

**Dariusz Fydrych^{1*}, Aleksandra Świerczyńska¹, Balázs Varbai², Kamil Wilk³,
Wojciech Suder⁴, Gürel Çam⁵, Chandan Pandey⁶**

¹ *Institute of Manufacturing and Materials Technology, Faculty of Mechanical Engineering and Ship Technology, Gdańsk University of Technology, G. Narutowicza Street 11/12, 80-233 Gdańsk, Poland*

² *ÁEF Materials Testing Laboratory Ltd, Budapest, Hungary*

³ *TWI Certification Ltd, Cambridge, United Kingdom*

⁴ *Welding and Additive Manufacturing Centre, Cranfield University, Bedfordshire, MK43 0AL, United Kingdom*

⁵ *Department of Mechanical Engineering, Iskenderun Technical University, Iskenderun 31200, Hatay, Türkiye*

⁶ *Department of Mechanical Engineering, Indian Institute of Technology Jodhpur N.H. 62, Nagaur Road, Karwar, Jodhpur 342030, India*

* *dariusz.fydrych@pg.edu.pl*

TUNGSTEN INERT GAS WELDING RESEARCH TRENDS: A 60-YEAR BIBLIOMETRIC ANALYSIS USING VOSVIEWER AND BIBLIOSHINY

ABSTRACT

Tungsten Inert Gas (TIG) welding constitutes a key process in the fabrication of welded structures, with widespread application across various sectors of modern industry. It continues to be the subject of extensive research due to its technical advantages and versatility. However, despite its industrial importance, TIG welding has not yet been the focus of a comprehensive bibliographic review. Therefore, the objective of this study is not only to present the current state of knowledge but also to identify key process directions and emerging research trends through a bibliometric analysis of 8,789 publications indexed in Web of Science. The analyses were performed mainly in VOSviewer 1.6.20 and Biblioshiny tools, determining the networks of connections between bibliometric entities: keywords, journals, authors, countries, and funding agencies. The analysis results were used to illustrate the dynamics of research topics over a 60-year publication history on the TIG process. Current research trends include, among others, the advancement of TIG welding variants to improve process efficiency, the application of artificial intelligence, the application of optimization methods, and deep learning. The most urgent research needs involve determining the weldability of special metals, assessing the environmental degradation of TIG-welded joints, and applying data mining techniques for the optimization of the TIG process. The study may serve as an objective, comprehensive, and author-unbiased complement to traditional systematic review articles on TIG welding and related processes.

Keywords: *Tungsten Inert Gas, Biblioshiny, VOSviewer, Web of Science, bibliometric analyses*

INTRODUCTION

Current demands across various branches of industry necessitate the broader application of welding processes, in particular arc welding, which remains the predominant method for joining components in welded structures throughout many manufacturing sectors [1–4]. The

most commonly used arc welding processes in industrial applications include Shielded Metal Arc Welding (SMAW) [5, 6], Tungsten Inert Gas (TIG) [7–9], Gas Metal Arc Welding (GMAW) [10–13], Flux-Cored Arc Welding (FCAW) [14–16], and Submerged Arc Welding (SAW) [17]. In addition, other advanced joining techniques are extensively applied, such as Laser Beam Welding (LBW) [18–20], Plasma Arc Welding (PAW) [21], Electron Beam Welding (EBW) [22–24], Resistance Welding [25, 26], and Friction Welding [27, 28], including Friction Stir Welding (FSW) [29–32].

The TIG process, designated as process 141 according to EN ISO 4063 and equivalently referred to as Gas Tungsten Arc Welding (GTAW), is an arc welding method that has established a prominent position across numerous industrial sectors [33, 34]. The principle of the process involves the use of a non-consumable tungsten electrode, shielding the welding zone from atmospheric contamination by an inert gas, and the application of a filler material, typically in the form of a rod, and less commonly, as wire [35]. Argon, helium, and mixtures of both are used as shielding gases. Less common and only for specific applications is the use of other welding gases as admixtures: nitrogen, hydrogen and oxygen [36–38]. The use of different gases significantly affects the stability of the process, the effectiveness of the gas shield, distribution of the arc energy and the morphology of the weld. The type of gas is therefore an important welding parameter, often determining the possibility of producing a welded joint of the required quality [39, 40]. When welding metals that are highly prone to oxidation at elevated temperatures (stainless steel, titanium, and aluminium alloys) it is necessary to apply purging gas from the root side [41]. This practice enhances the quality, appearance, and mechanical performance of the welded joints. As purging gases, depending on the material and technological conditions, the most commonly used are: pure argon (I1 according to EN ISO 14175), argon with hydrogen addition (R1: 2–5% H), pure nitrogen (N1), or nitrogen with hydrogen addition (N5: 5–20% H) [42–44]. A welding backing serves a similar function: it is used to support the welding pool, shape the weld root, and protect it from atmospheric contamination, particularly when equipped with a purging gas channel, and may also influence the welding thermal cycle, which helps ensure proper penetration and microstructure and reduces the risk of joint defects [45, 46].

The most significant limitation of the TIG process is its relatively low deposition rate [47]. Nevertheless, this characteristic allows for high-precision welding of extremely thin materials, including components with wall thicknesses below 1 mm. In such cases (up to 5 mm, depending on the base material composition), the process can be conducted autogenously (process 142), without the addition of filler metal [48–50]. Although traditionally performed as a manual process, advancements in automation and robotic integration have enabled TIG welding to be fully incorporated into automated production systems [51–53]. Orbital TIG welding solutions for pipes have also been developed, enabling the consistent production of high-quality, repeatable welds that meet strict acceptance criteria, while mitigating the traditional limitations of the process [54, 55].

The TIG welding process is widely applied across various industrial sectors, including aerospace, automotive, shipbuilding, chemical, petrochemical, energy, food, and pharmaceutical industries, as well as in the fabrication of pressure vessels and piping systems [56–60]. The process is extremely rarely used underwater, where in practice methods based on a consumable electrode are preferred [61–64]. More detailed areas of industrial application of the TIG process include the welding of thin components [65, 66], root passes in combined welding procedures [67, 68], and pipe joints [69]. An important area of application of the process is also the surfacing of metals, particularly when a low dilution of the base material in

the weld overlay is required [70–72]. Despite its low productivity and the requirement for extensive operator training, the TIG process remains highly regarded due to its ability to produce welds of superior quality, excellent metallurgical cleanliness, and precise geometry [73]. Importantly, it is highly versatile in terms of metallurgical compatibility, enabling the joining of a wide range of ferrous [74–76] and non-ferrous materials, including nickel, aluminium, magnesium, titanium, copper, and their alloys [77–81]. In the field of steel welding, the process is applied to the fabrication of joints in non-alloyed and alloyed steels, including stainless, heat-resistant, creep-resistant, cryogenic, wear-resistant, and armor steels [82–86]. A major part of the research deals with issues related to the fabrication of dissimilar joints and the associated challenges arising from differences in the physicochemical properties of the welded materials [87–90]. The large number of possible material and technological combinations necessitates the development of processes with carefully selected consumables, preheating parameters, heat treatment, weld bead sequences, the application of buffer layers, and combined procedures [91–95]. Equally important are considerations related to welder safety and the overall costs of manufacturing welded structures, which must not be overlooked [96–98].

Depending on the operating environment in which TIG-welded joints are employed, researchers emphasize the critical role of both static strength and fatigue resistance [99–102]. Abrasion resistance also constitutes an important operational parameter, particularly under conditions involving intensive mechanical interaction [7, 57]. Corrosion resistance, including intergranular corrosion, hot corrosion, high-temperature oxidation, and environmental degradation forms, is equally significant [103–105]. For joints intended for service in power generation systems, particular attention is devoted to the heat resistance of welded joints and their structural stability under elevated temperature conditions [71, 106, 107]. Fundamental research is also being conducted on the thermal processes occurring during welding and the behavior of molten metal in the welding pool [108–110].

In pursuit of increased process efficiency, numerous technological modifications and variants of the TIG process have been introduced, including pulsed TIG [111–113], A-TIG [114, 115], orbital TIG [116], hot-wire TIG [117, 118], keyhole TIG (K-TIG) [119, 120], TopTIG [121], as well as hybrid processes that combine TIG with other energy sources such as laser [122–124]. A specific hybrid configuration consists of processes integrating TIG and MIG (Metal Inert Gas) welding method [125, 126]. Other methods of improving the quality of welded joints involve coupling the process with physical influences, such as magnetic or ultrasonic fields [127–129]. These external factors affect the process either by modifying the electric arc or by influencing the crystallization of the welding pool. Furthermore, TIG welding is increasingly applied in the field of metal additive manufacturing, particularly in Wire Arc Additive Manufacturing (WAAM), where arc stability and precise process control are critical to achieving layer consistency and material integrity [130–133]. A notable advantage, arising from the non-consumable nature of the tungsten electrode, is the capability to remelt base material or existing welds [134]. This approach can be employed to reduce defect rates and to induce beneficial microstructural transformations, ultimately enhancing both the mechanical performance and visual appearance of the weld [135].

Scientometrics, the discipline focused on measuring and analyzing scientific activity, constitutes a key area of contemporary scientific research. It includes bibliometric analysis, which involves a range of analytical and statistical techniques used to quantitatively examine scientific outputs such as publications, citations, authors, institutions, and journals [136]. Science mapping employs various software tools that facilitate the import, transformation,

and processing of data extracted from bibliographic databases such as Web of Science, Scopus, Crossref, and Dimensions. These tools support the generation of tabular reports and visualizations, particularly maps and network plots, that depict relationships among the analyzed entities [137–139]. The most widely used bibliometric tools include VOSviewer, Bibliometrix (and its web-based interface Biblioshiny), CitNetExplorer, HistCite, Gephi, and Pajek [140–143].

Web of Science is one of the oldest and most important bibliographic scientific databases, offering access to high-quality peer-reviewed articles and citation indexes [144]. Users value it for its reliable sources and extensive bibliometric tools. The database is often used as a data source for bibliometric analyses, which help assess the scientific significance and impact of bibliometric entities [145].

The WOS database indexes 124 review papers on TIG welding technology. Some of these publications focus specifically on the TIG process, discussing the current state of knowledge and development trends in relation to process parameters and its applications across various industries [146–149]. Other studies address TIG as part of a broader technological and material science context, for example, in comparison with other welding methods, in the processing and application of advanced materials, or in the context of automation and robotization of industrial manufacturing processes [150–154]. Despite the large number of review articles on the TIG welding process, only one study has applied bibliometric analysis, and even then, it was limited to basic citation and publication metrics [155]. For this reason, the aim of the present study was, based on the results of bibliometric analyses of data obtained through an unrestricted temporal and territorial query in the Web of Science database, to determine the current state of knowledge and development of the TIG process, identify prevailing research trends, and highlight knowledge gaps that warrant further investigation.

BIBLIOMETRIC ANALYSES

Methodology

For the bibliometric analyses, popular software tools were employed: VOSviewer 1.6.20 and Biblioshiny, supported by built-in analytical functions of the Web of Science (WOS) and data preparation in Microsoft Excel. The data were retrieved from WOS on December 1, 2025, using the following search terms: “TIG welding” (4,439 publications), “GTAW welding” (2,914 publications), “tungsten inert gas” (3,129 publications), and “gas tungsten arc welding” (4,787 publications). Following the formal preparation and substantive verification of all 15,269 collected publications, 8,789 papers were qualified for further analysis. Formal preparation and substantive verification consisted of removing duplicate (6479) and retracted (1) publications, as well as reviewing the bibliographic information and abstracts to determine the thematic relevance of each work to the scope of this review. This process was conducted manually by carefully reading and assessing each publication, without the use of automated tools. No restrictions were applied to the collected data with regard to publication date, authors’ institutional affiliation (country), or language. VOSviewer 1.6.20 and Biblioshiny tools were used due to their complementary capabilities [156, 157]. The VOSviewer tool enables the visualization of co-occurrence networks of bibliographic entities such as authors, countries, and journals, allowing for an intuitive understanding of the research structure [158]. Co-occurrence networks visualize how frequently bibliographic entities appear together in publications [142, 156, 158]. Biblioshiny, on the other hand, offers advanced statistical tools

for bibliometric data analysis, facilitating the exploration of publication trends and collaboration patterns among these bibliographic entities [159, 160]. Figure 1 shows a schematic representation of the methodological framework for analytical and bibliographic research.

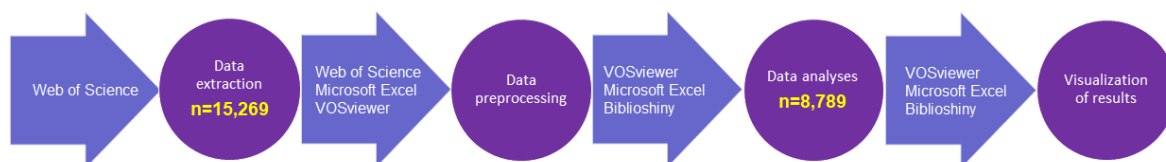


Fig. 1. Methodological scheme of analytical and bibliometric studies

Exploring Publication and Citation Patterns

The statistical characteristics of the analyzed dataset (8,789 publications from 1965 to 2025) are presented in Tables 1 and 2. Since a single publication may be assigned to multiple categories, the values in Table 1 do not sum to the total number of publications. In addition to standard research papers, scientific achievements in the field of TIG welding are presented at scientific conferences and published in their proceedings. The significant number of review articles (124) indicates the need for a systematic synthesis of knowledge in the field of TIG welding, identification of research gaps, and the definition of directions for future scientific and industrial work. Data papers are relatively rare in this field, with only three identified cases [161–163]. This limitation constrains the development of the research area by hindering result verification and reducing the potential for applying big data analytics, data mining, and machine learning methods [164]. The analyzed dataset comprises 1,549 types of sources, 110,724 references, and 15,681 authors, with an average of 3.78 co-authors per document and 12.58% international collaborations. Among the 8,789 publications, 325 were authored by a single researcher. These indicators suggest a moderate level of collaborative research within the field. English dominates as the primary language of publication (96.37%), while among languages represented by at least ten works, publications appeared in Chinese (1.30%), Portuguese (0.88%), Korean (0.26%), German (0.24%), Spanish (0.23%), Japanese (0.21%), and French (0.17%). In addition, WoS categorizes 22.38% of the publications under different types of Open Access modes.

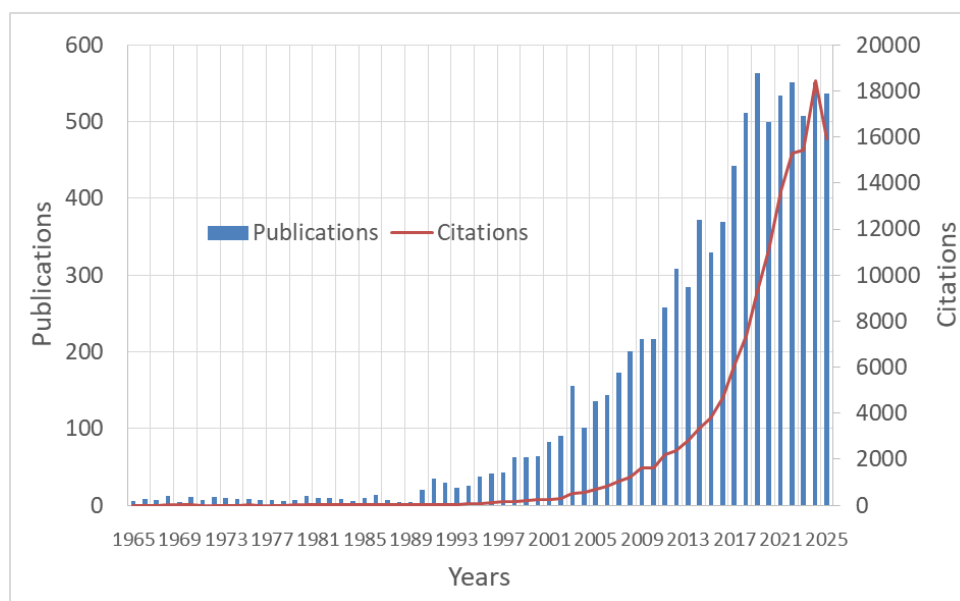
Table 1. Types of publications (WOS)

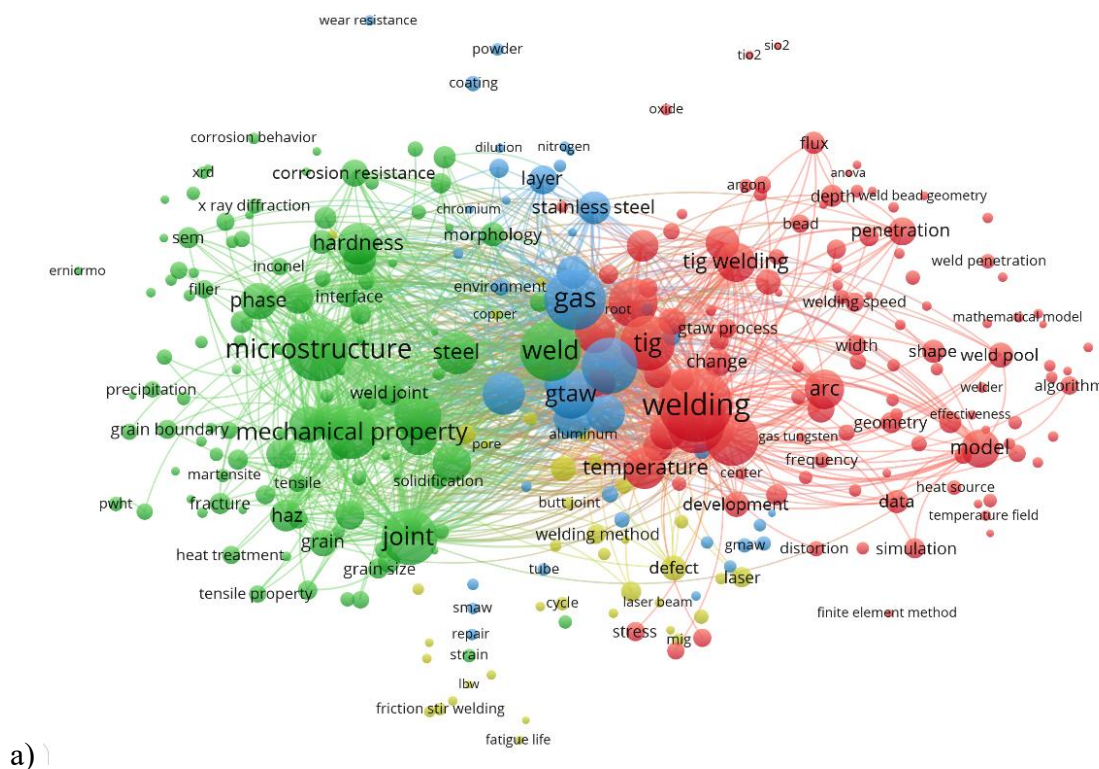
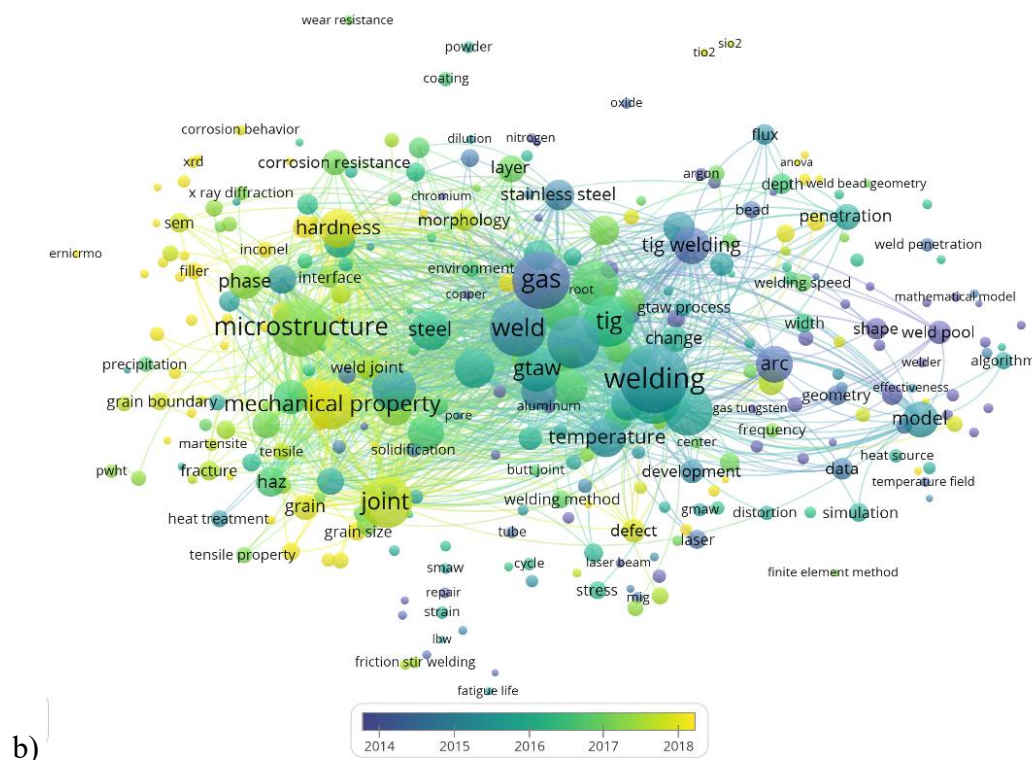
Document Types	Count
Article	7,031
Proceedings paper	1,762
Review	124
Early access	99
Editorial material	26
Book chapter	22
Note	17
Letter	16
Correction	5
News item	5
Data paper	3
Meeting abstract	4
Book review	2

Table 2. Overview of the analyzed bibliometric dataset (*Biblioshiny*)

Description	Results
Timespan	1965:2025
Types of sources	1,549
Average citations per document	15.64
References	110,724
Authors	15,681
Single-authored documents	325
Co-authors per doc	3.78
International co-authorships %	12.58

Publication and citation trends from 1965 to 2025 are presented in Figure 2. From 1965 to 1990, both publication output and citation counts were minimal. This was primarily due to the limited number of journals indexed in the only international database available at that time, Web of Science (formerly Science Citation Index), as well as the overall lower publishing activity characteristic of that period [165]. In many countries, particularly outside the Western world, research findings were published mainly in local journals and national languages, which restricted their visibility in the global scientific community. Furthermore, low levels of research funding and a preference for monographs, internal reports, and conference proceedings over peer-reviewed journal articles further contributed to the limited number of publications indexed in Web of Science. A gradual increase in publications began in the early 1990s, accelerating significantly after 2000. The period 2010–2020 witnessed a marked rise in interest in the topic, culminating in peak publication volumes of approximately 500–550 per year between 2018 and 2022. Concurrently, citation counts grew exponentially, exceeding 18,000 by 2024. Notably, a clear correlation is observed between the number of publications and the number of citations within this research area [166]. The small decrease in values for 2025 is due to incomplete data (as of December 1). This pattern of an extended initial phase followed by rapid growth and subsequent stabilization is characteristic of maturing research areas in welding [138, 140, 142]. Overall, the 8,789 publications in the analyzed dataset were cited 135,918 times across 56,934 papers indexed in WoS, resulting in an average of 15.64 citations per article. The h-index for this dataset is 115.

**Fig. 2.** Trends in TIG welding research publications (WOS). The value for 2025 is current up to December 1.



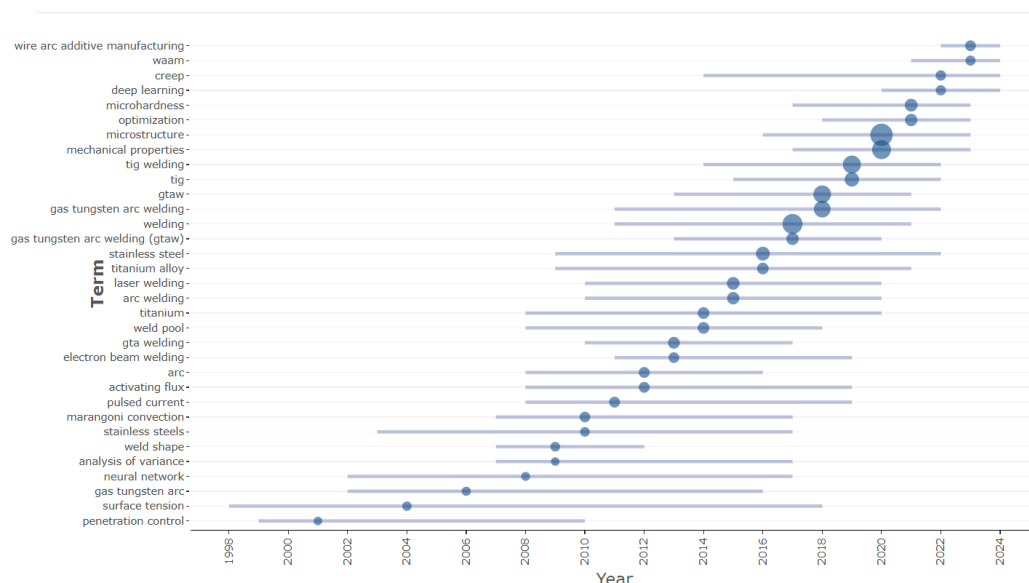


Fig. 5. Trends in TIG welding research topics derived from authors' keywords (Biblioshiny)

Journals

Figure 6 shows the 20 journals most frequently selected by authors for publications on the TIG process, with the first 14 belonging to Zone 1 as described by Bradford's law [178]. According to Bradford's law, a small number of journals publish the majority of significant articles in a given field, while the remaining journals contain progressively fewer articles on the topic. Three groups of journals can be distinguished: the core, the middle zone, and the peripheral zone [179]. For core journals, a cumulative publication plot on the topic under consideration is presented in Figure 7. Figure 8 presents VOSviewer maps illustrating the network of relationships among the journals shown in Figure 6, based on mutual citations.

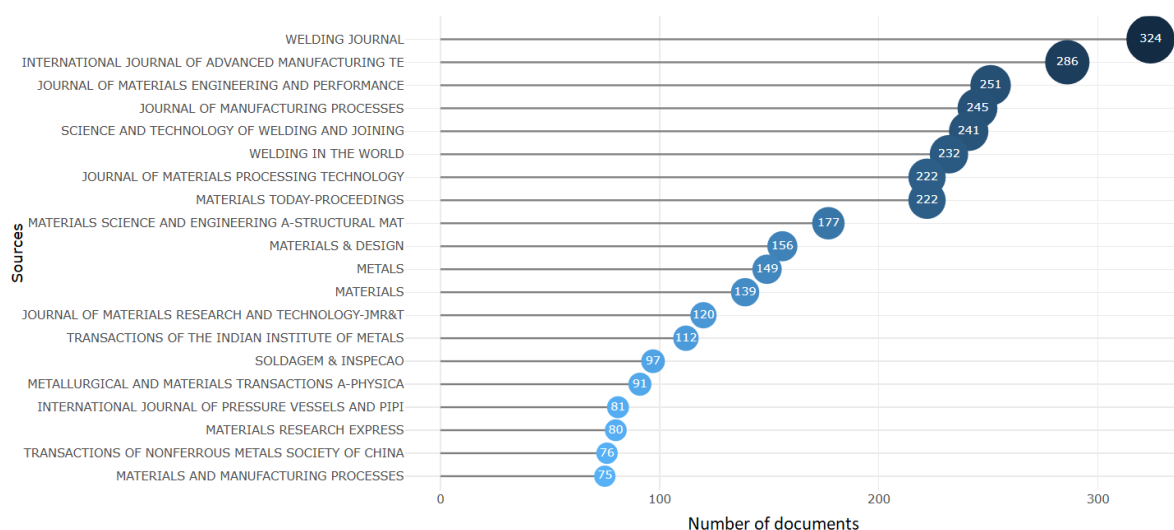


Fig. 6. Number of publications on TIG processes per journal (Biblioshiny)

Although Welding Journal is the most frequently chosen source by authors (Figures 6 and 7), it is the oldest journal in the analyzed set. To account for differences in the time of activity

of journals, the year of the first publication on the TIG process was taken as the starting point and the average annual publication growth was calculated. The highest values were recorded in Journal of Manufacturing Processes, Metals, and Materials Today: Proceedings, while the lowest were observed in Transactions of the Indian Institute of Metals, Welding in the World, and Journal of Materials Research and Technology (JMR&T).

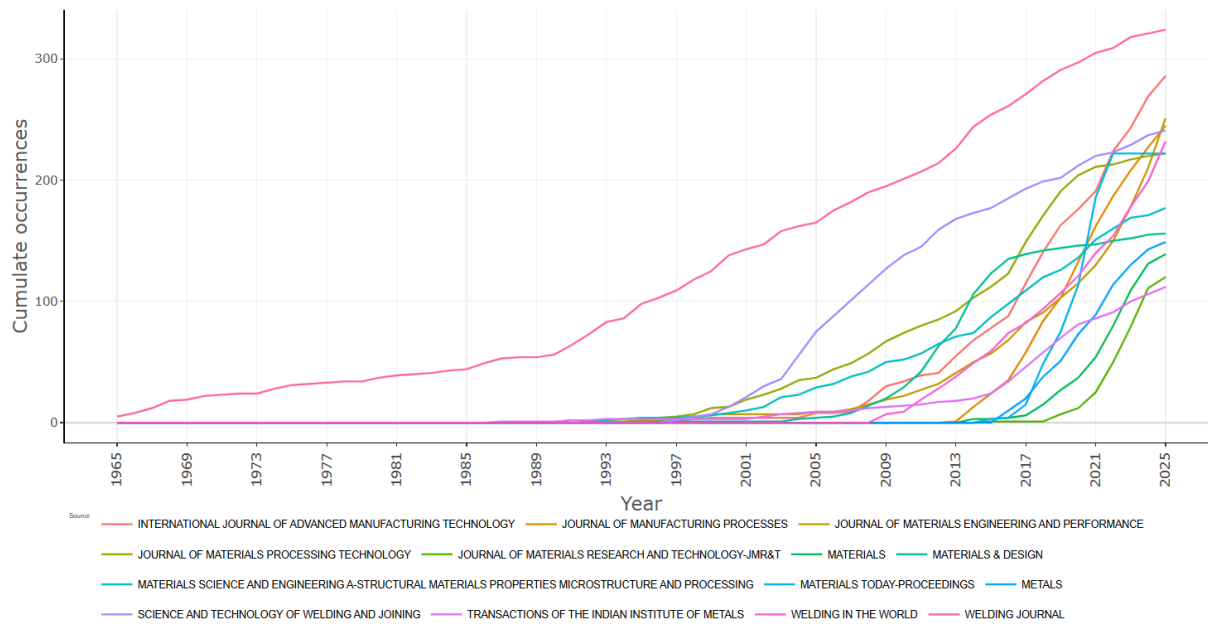
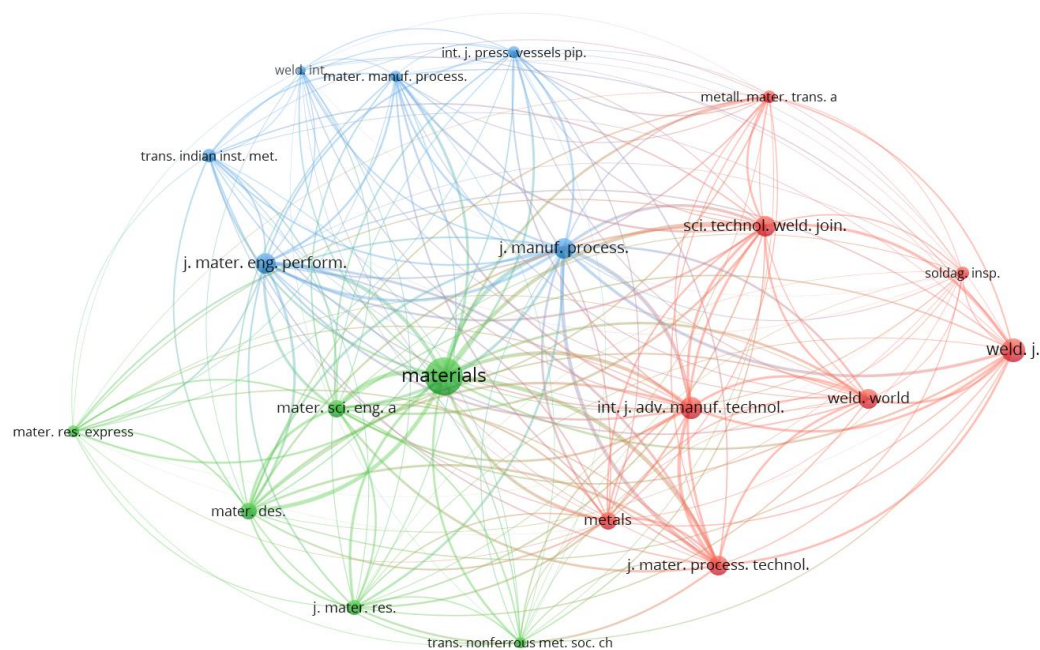


Fig. 7. Cumulative number of publications on TIG process over time for the 14 journals in Zone 1 (Bradford's law) (Biblioshiny)



a)

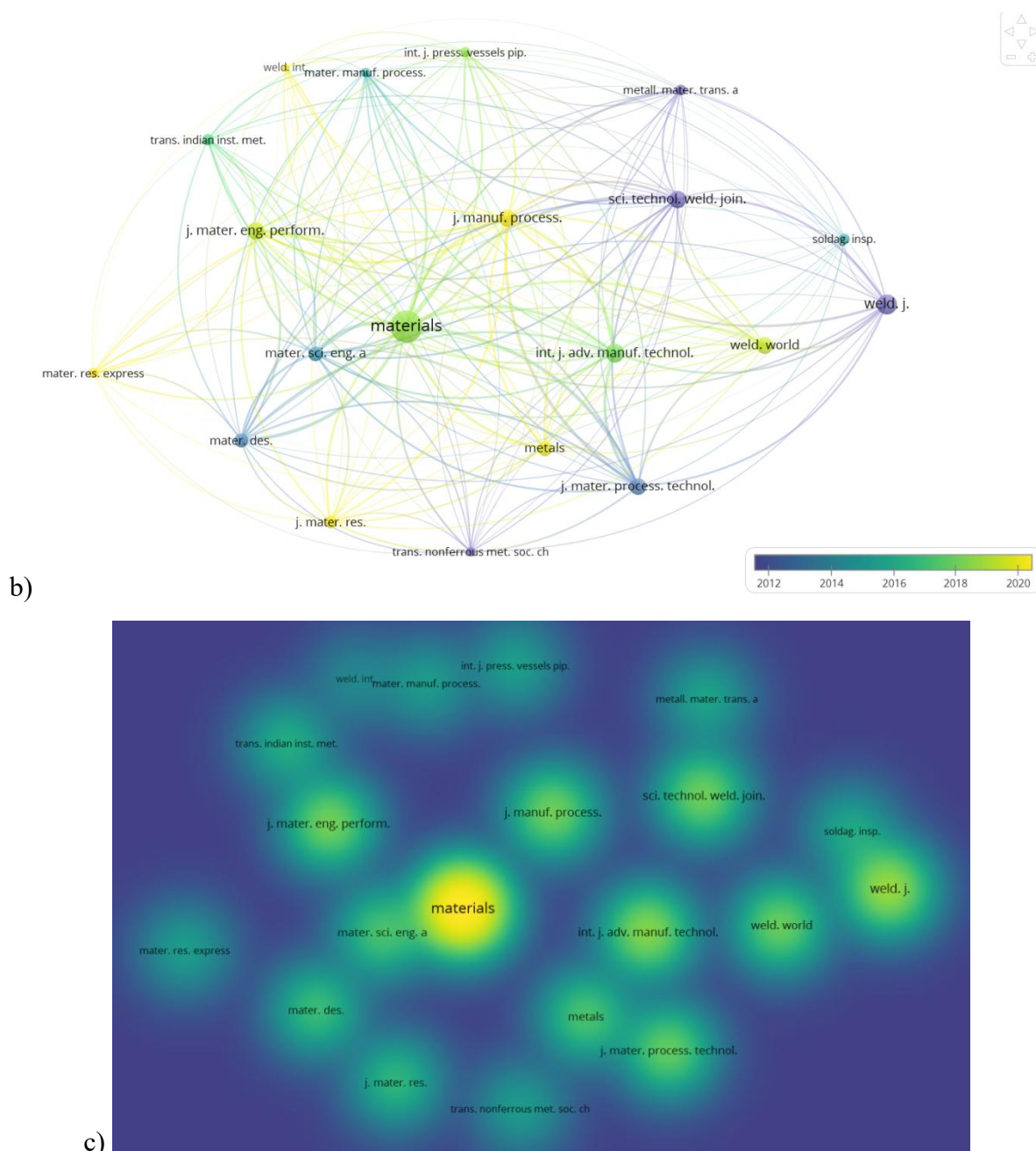


Fig. 8. Bibliometric visualization of TIG process literature sources: a) sources network, b) sources network overlay c) sources density (VOSviewer)

The majority of publications on TIG welding are concentrated in a limited number of leading journals, which serve as the primary sources of literature for researchers in this field. Nonetheless, shifts in the prominence of individual journals are evident, potentially influenced by factors such as open access publishing models, variations in the number of articles published, and requirements from research funding institutions to publish in reputable journals with a high impact factor. An example is the decreasing average number of publications in *Materials and Design*, *Welding Journal*, and *Science and Technology of Welding and Joining* accompanied by a simultaneous increase in *Materials Today: Proceedings*, *Metals*, and *Journal of Manufacturing Processes*. Citation network analysis (Figure 8a) revealed three distinct clusters of journals: one focused specifically on welding (highlighted in red), and two encompassing sources related to broader topics in materials

science as well as materials manufacturing and processing techniques (green and blue). The citation network exhibits a relatively uniform structure, suggesting frequent and evenly distributed cross-citation among journals within the research domain.

Authors

Table 3 presents a summary of the ten leading authors who have published more than 65 articles on TIG welding. Four researchers have published more than 100 papers on this topic: S.B. Chen, Y.M. Zhang, L.M. Liu, and M. Vasudevan. Figure 9 illustrates the temporal distribution of publication activity for these ten authors.

Table 3. Leading authors of TIG processes literature (WOS)

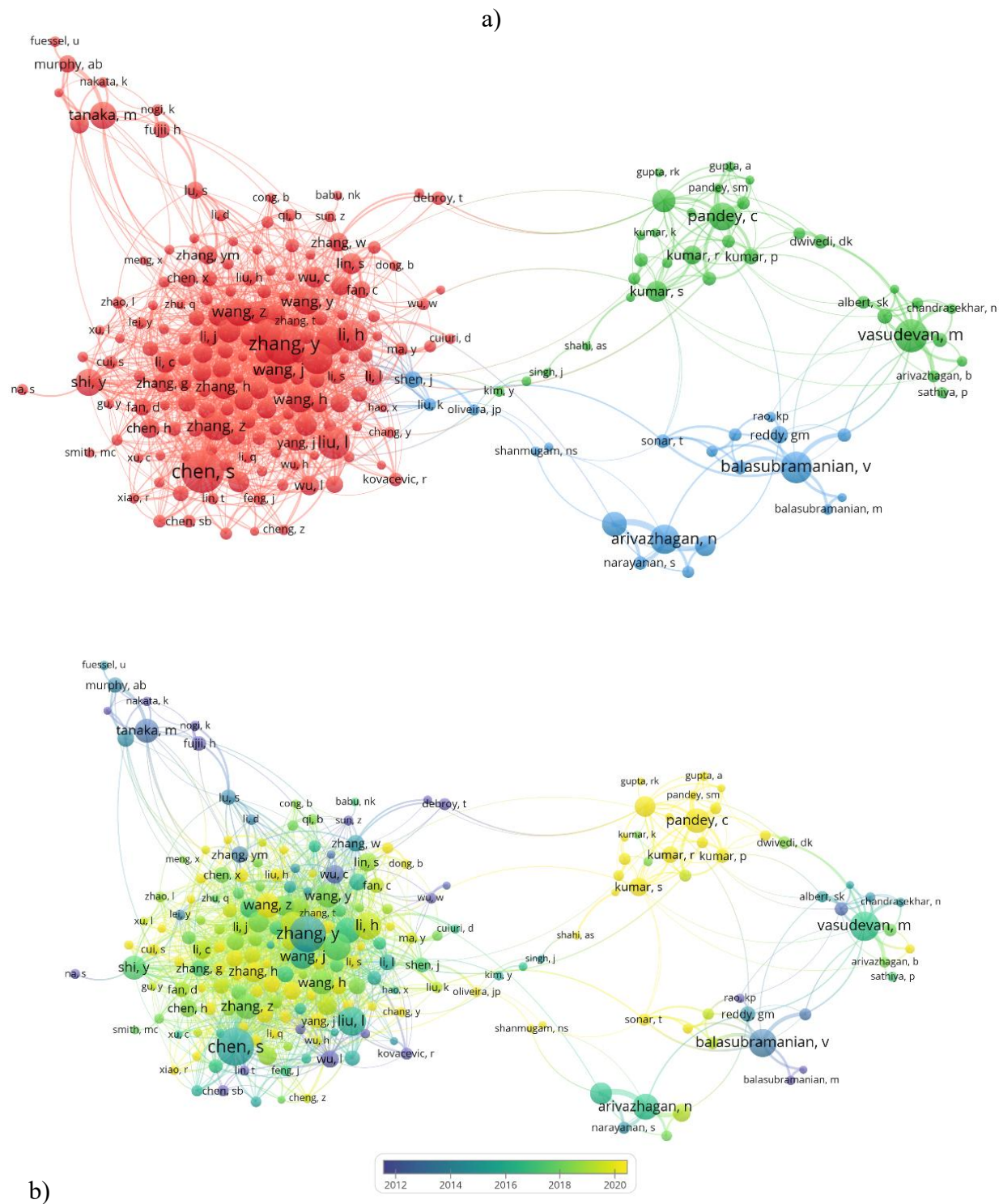
Authors	Affiliation	Number of publications	% of n=8,789	Citations	Citations per publication
Chen SB	Shanghai Jiao Tong University, School of Materials Science and Engineering, Shanghai, China	125	1.439	3277	26.2
Zhang YM	Department of Electrical and Computer Engineering and Institute for Sustainable Manufacturing, University of Kentucky, Lexington, USA	119	1.370	3164	26.6
Liu LM	School of Materials Science and Engineering, Dalian University of Technology, Dalian, China	108	1.243	2437	22.6
Vasudevan M	Metallurgy and Materials Group, Indira Gandhi Centre for Atomic Research, Kalpakkam, India	108	1.243	2796	25.9
Balasubramanian V	Faculty of Engineering and Technology, Annamalai University, Annamalainagar, Tamilnadu	99	1.140	2780	28.1
Arivazhagan N	School of Mechanical Engineering, Vellore Institute of Technology, Vellore, TN, India	90	1.036	2177	24.2
Pandey C	Department of Mechanical Engineering, Indian Institute of Technology, Jodhpur, India	81	0.932	2162	26.7
Tanaka M	Joining and Welding Research Institute (JWRI), Osaka University, Osaka, Japan	80	0.921	2156	27.0
Ramkumar KD	School of Mechanical Engineering, VIT University, Vellore, India	75	0.863	1992	26.6
Lin SB	State Key Laboratory of Advanced Welding and Joining, Harbin Institute of Technology, China	65	0.748	1906	26.2

A clear difference in the duration of publication activity can be observed: some researchers (e.g., SB Chen, YM Zhang, M Tanaka) have been active since the 1990s, whereas others (e.g., C Pandey, KD Ramkumar, SB Lin) began publishing intensively only after 2010. It is worth noting that the past ten years have witnessed a substantial increase in publication output, highlighting the expanding focus on TIG welding. Furthermore, despite the varying lengths of research careers, the more recent authors have achieved a publication intensity comparable to that of the earlier leaders, indicating both the expansion of the active research community and the intensification of developments in this field. Interestingly, regardless of the publication period and the total number of articles produced, the average number of citations per paper remains both relatively high and consistent, ranging from 22.6 to 28.1. This indicates that, independent of publication intensity, their works exert a comparable impact within the scientific community.



Fig. 9. Publication output of the ten most prolific authors in the field of TIG welding (Biblioshiny)

The visualization networks shown in Figure 10 illustrate co-authorship relationships among 219 researchers in TIG process research, developed based on a minimum publication threshold of 15 and using the fractional counting procedure. The network is extensive, with multiple connections between nodes representing authors. The main findings are consistent with previous analyses: several leading research groups are centered around SB Chen, YM Zhang, M Tanaka, and Balasubramanian, who published earlier works, while the most recent publications appear in teams led by C Pandey, KD Ramkumar, and N Arivazhagan.



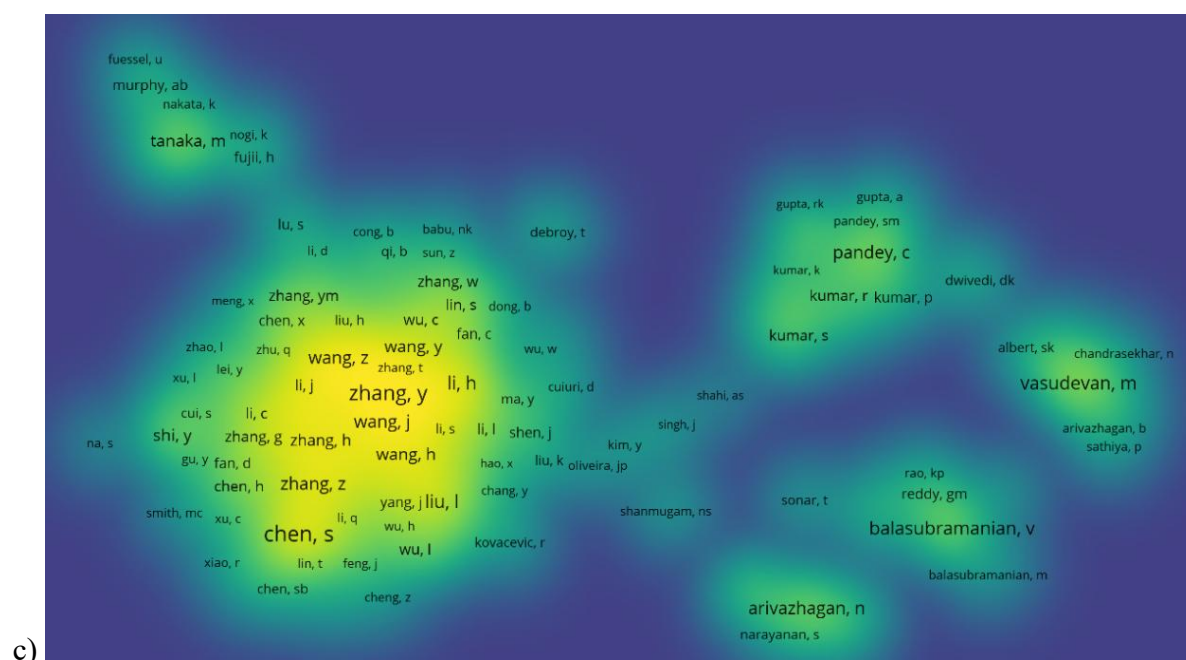


Fig. 10. Bibliometric visualization of co-authorship in TIG process literature: a) sources network, b) sources network overlay c) sources density (VOSviewer)

Table 4 presents the five publications with the highest citation counts according to the Web of Science (WOS). These studies address topics extending beyond conventional TIG welding, encompassing aspects of additive manufacturing using TIG [180, 181] as well as articles on the weldability of ferritic–austenitic duplex steels and nickel alloys [182–184]. This clearly indicates that among current research trends, additive manufacturing holds a significant position, particularly WAAM (Wire Arc Additive Manufacturing), which is a process that uses an electric arc as a heat source to build metal components layer by layer from wire feedstock.

Table 4. The top five publications with the highest number of global citations (WOS)

Article	Citations	Citations per year
Baufeld, B., Van der Biest, O., & Gault, R. (2010). Additive manufacturing of Ti–6Al–4V components by shaped metal deposition: microstructure and mechanical properties. <i>Materials and Design</i> , 31, S106-S111.	477	27.8
Muthupandi, V., Srinivasan, P. B., Seshadri, S. K., & Sundaresan, S. (2003). Effect of weld metal chemistry and heat input on the structure and properties of duplex stainless steel welds. <i>Materials Science and Engineering: A</i> , 358(1-2), 9-16.	419	19.0
Henderson, M. B., Arrell, D., Larsson, R., Heobel, M., & Marchant, G. (2004). Nickel based superalloy welding practices for industrial gas turbine applications. <i>Science and Technology of Welding and Joining</i> , 9(1), 13-21.	388	18.4
Dinovitzer, M., Chen, X., Laliberte, J., Huang, X., & Frei, H. (2019). Effect of wire and arc additive manufacturing (WAAM) process parameters on bead geometry and microstructure. <i>Additive Manufacturing</i> , 26, 138-146.	330	55
Verma, J., & Taiwade, R. V. (2017). Effect of welding processes and conditions on the microstructure, mechanical properties and corrosion resistance of duplex stainless steel weldments—A review. <i>Journal of Manufacturing Processes</i> , 25, 134-152.	320	40

Countries

Based on the statistical distribution of countries in which the authors of publications on the TIG process are affiliated (Table 5 presents regions that account for at least 1% of the 8,789 publications), a strong concentration is observed in a few countries, while the contribution of many others remains relatively minor. The largest share is represented by China (26.3%) and India (21.4%), which together account for nearly half of all records. The United States ranks third but with a significantly smaller share (9.1%). The high share of publications authored by researchers affiliated with institutions in these three countries results from multiple factors. First, the data are presented in absolute terms, and these countries have a substantial number of researchers. Moreover, industry plays a significant role in their economies, which drives interest in manufacturing technologies. The high publication output is also supported by extensive higher education systems and numerous research institutions, strong engagement of funding agencies, significant investments in research and development enabling advanced scientific projects, and a well-established publication culture in which scholarly articles constitute a key metric for assessing academic careers and research institutions. Asian countries: China, India, Japan, Iran, South Korea, and Taiwan dominate the top ten, highlighting the region's significance in this field, whereas the contribution of European countries is considerably lower, with none exceeding 3.5%.

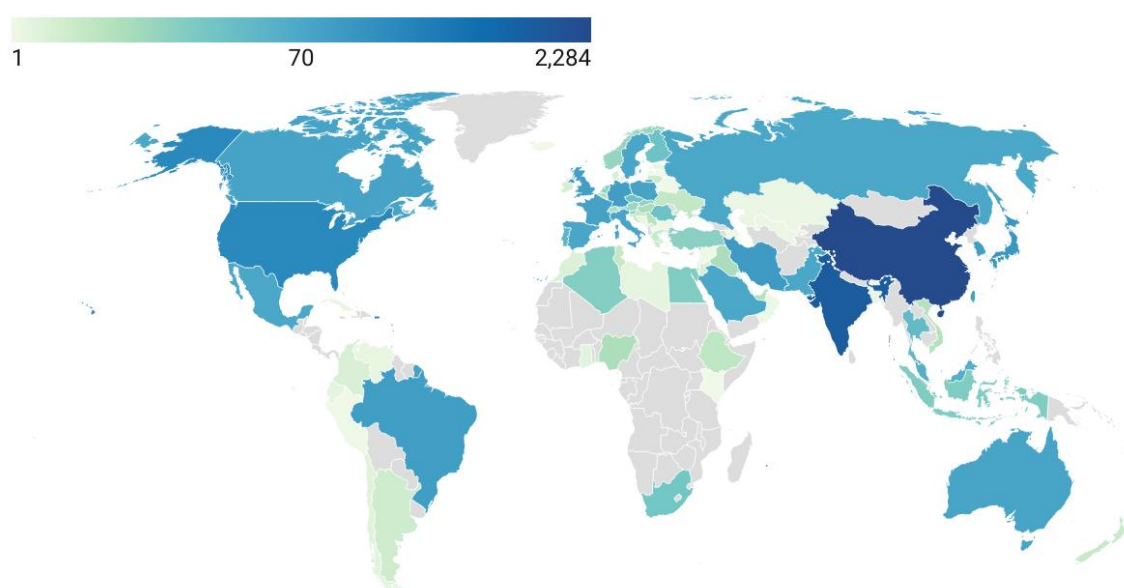
Table 5. Leading countries of TIG processes literature (WOS)

Country	Record Count	Share of total, n=8,789 (%)
Peoples Republic of China	2284	26.3
India	1863	21.4
United States	789	9.1
Japan	447	5.1
Iran	368	4.2
Brazil	316	3.6
South Korea	310	3.5
Germany	300	3.4
England	281	3.2
France	201	2.3
Taiwan	190	2.1
Poland	173	1.9
Canada	162	1.8
Australia	146	1.6
Turkey	138	1.5
Italy	121	1.3
Spain	101	1.1
Sweden	91	1.0

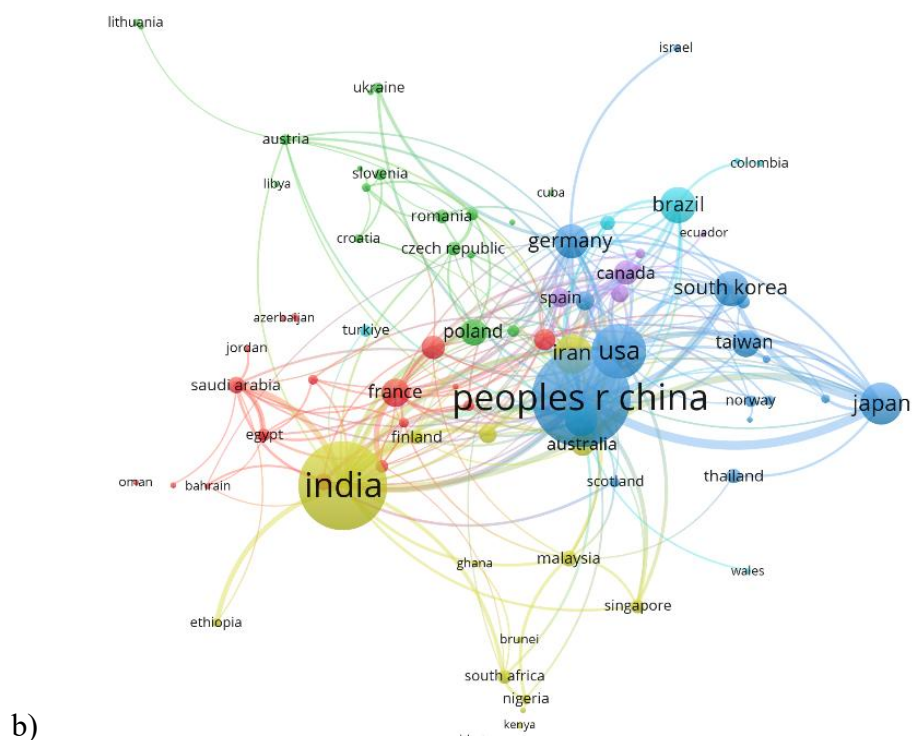
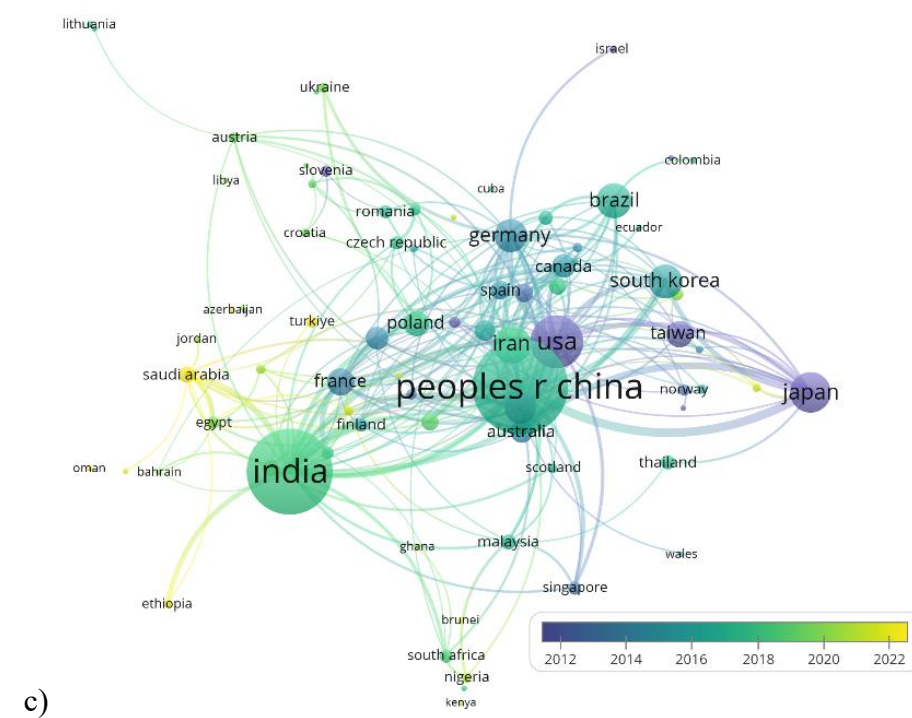
Figure 11 presents the global mapping of TIG welding research and inter-country collaboration links. Analysis of the co-authorship network of scientific publications on TIG welding indicates a progressive globalization of research and a clear shift of activity from Western countries toward Asia and developing nations (Figure 11b). China plays a leading role in this process, whereas India focuses primarily on regional collaboration and partnerships with countries in the Global South. The largest nodes in the network,

corresponding to the highest number of publications and co-authorship links, are represented by China, India, the United States, Japan, Germany, Iran, Brazil, and South Korea. Additionally, medium-sized centers, such as France, Poland, Saudi Arabia, and Malaysia, serve as bridges between major players and smaller countries. The network structure allows the identification of six main research clusters. The first, the Asian cluster (blue), includes China, Japan, South Korea, and Taiwan, maintaining strong connections with the United States and Germany. The second cluster (yellow-green) is centered around India, which collaborates intensively with the Gulf countries, Sub-Saharan African nations (Nigeria, South Africa), and countries in Southeast Asia. The third, European cluster (green), includes Germany, Poland, the Czech Republic, Romania, Austria, and Ukraine. Another, Middle Eastern cluster (red) comprises Saudi Arabia, Egypt, Jordan, and Turkey, which maintain strong links with India and Europe. A separate Latin American cluster (turquoise) is formed by Brazil, Colombia, and Ecuador, primarily connected with Germany, the United States, and Spain. The final group consists of smaller peripheral clusters, represented by countries such as Lithuania and Ethiopia (light green).

Temporal analysis of publication activity reveals heterogeneous growth rates across countries (Figure 11c and d). Established research centers include Japan, the United States, and Germany. In the more recent period (2018–2022), dynamic growth in publication activity was observed in India, Saudi Arabia, Egypt, Malaysia, and Nigeria. China, on the other hand, has demonstrated a consistently sustained research output over an extended period. Analysis of international collaborations confirms particularly strong cooperation among China, the United States, Germany, and Japan, while highlighting the role of Central European countries, such as Poland, the Czech Republic, and Romania, as connectors between East and West. The activity of Middle Eastern and African countries is steadily increasing, as they integrate into the global research network. India plays a particularly significant role as a regional hub, facilitating mainly South–South cooperation that integrates countries across Asia, Africa, and the Middle East.



a)



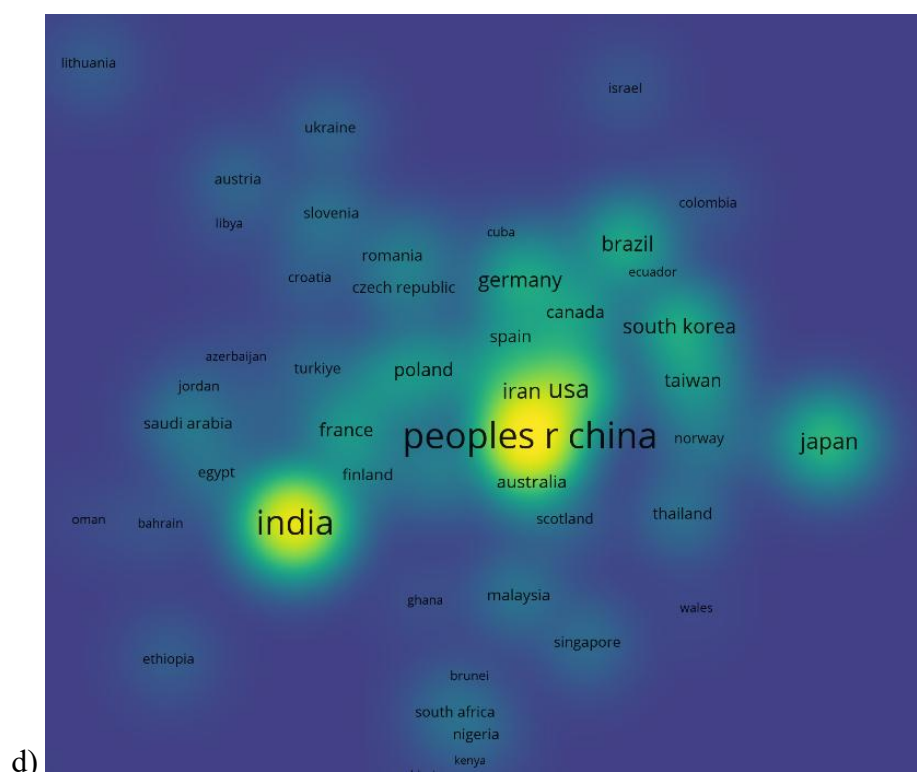


Fig. 11. Global research landscape of TIG welding: a) world map (<https://www.datawrapper.de/maps/choropleth-map>), b) countries network, c) countries network overlay, d) countries density (VOSviewer)

Funding

Analysis of data from the WOS allows for the identification of previous sources of research funding, thereby revealing potential opportunities for applying for research grants. In the case of data concerning TIG welding, assuming a minimum numerical share of 1% per funding institution, China emerges as the leading contributor, accounting for nearly 20% of all projects, with the largest share (12.2%) provided by the National Natural Science Foundation of China (NSFC). Brazil occupies the second position, primarily due to the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), supported by state foundations and industry. The United States and Europe together finance approximately 5–6% of research, with dominance by the National Science Foundation (NSF) in the United States (0.92%) and the United Kingdom Research and Innovation (UKRI) in the UK (0.69%). India and Japan have a similar share, around 1.2% each, with the main sponsors being the Department of Science and Technology (DST) in India and the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in Japan (0.46%). Poland and other Central European countries do not exceed a 1% share in funding TIG research. Table 6 lists ten funding agencies that supported the highest number of publications within the dataset of 8,789 articles. Many other institutions are also funding these studies, but each contributes only to a minor extent. It should be emphasized that these analyses consider only the number of projects, not the funding amounts. Nevertheless, the results are consistent with the patterns observed in analyses of the countries and institutions with which the authors are affiliated (Tables 3 and 5, Figures 9-11).

Table 6. Top 10 funding agencies supporting the largest number of publications from the set of 8,789 articles

Funding Agencies	Record Count	Share of total, n=8,789 (%)
National Natural Science Foundation Of China NSFC	1057	12.166
Fundamental Research Funds For The Central Universities	105	1.209
National Key Research Development Program Of China	99	1.140
Conselho Nacional De Desenvolvimento Cientifico E Tecnologico CNPQ	93	1.070
National Science Foundation NSF	80	0.921
China Postdoctoral Science Foundation	73	0.840
Coordenacao De Aperfeicoamento De Pessoal De Nivel Superior Capes	69	0.794
Ministry Of Science And Technology Taiwan	65	0.748
UK Research Innovation UKRI	60	0.691
Engineering Physical Sciences Research Council EPSRC	56	0.645

SUMMARY

The subject of this study is the analysis of records from the Web of Science database, comprising bibliographic descriptions of 8,789 publications on TIG welding. The inclusion criteria for the dataset were strictly limited to relevance, without imposing any additional restrictions. The application of bibliometric tools, mainly VOSviewer 1.6.20 and Biblioshiny, and the subsequent analysis of the results made it possible to determine the current state of knowledge and its evolution over the past 60 years, beginning with the publication of the first Web of Science-indexed paper on the TIG method. This approach provided insight into the dynamic development of research in this field, covering a wide thematic spectrum, and served as a basis for identifying research gaps and potential future directions.

The majority of publications are written in English (96.37%) and consist primarily of standard research articles, with a relatively substantial number of review papers (124). Data papers are rare exceptions, indicating limited availability of raw data, which may hinder the replication of studies and the verification of results. The dominance of standard research articles suggests that the main focus is on the interpretation of results rather than on sharing underlying datasets [185]. The publication trend in TIG welding reflects patterns typical of materials engineering and welding research [138, 140, 142]. The development of research, as analyzed using bibliometric methods, can be divided into an initial low-activity phase (1965–1990), a growth phase beginning in the early 1990s, and a phase of intensive expansion after 2000.

While single-authored publications are relatively rare, the degree of international collaboration in this field is still limited. The international collaboration rate of 12.58% should be regarded as a significant limitation to the development of research in the field of TIG welding [186]. Compared with global trends, this value is relatively low, which may negatively affect the quality, innovation potential, and international visibility of research outcomes [187]. International partnerships play a crucial role in facilitating knowledge exchange, jointly addressing scientific challenges, and advancing modern technological solutions. Moreover, they significantly support the acquisition of research funding,

particularly from supranational sources [188, 189]. Therefore, strengthening international cooperation between research institutions should be considered a key priority for the further development of this field. Such an approach may substantially accelerate scientific progress and enhance the global impact of research on TIG welding processes.

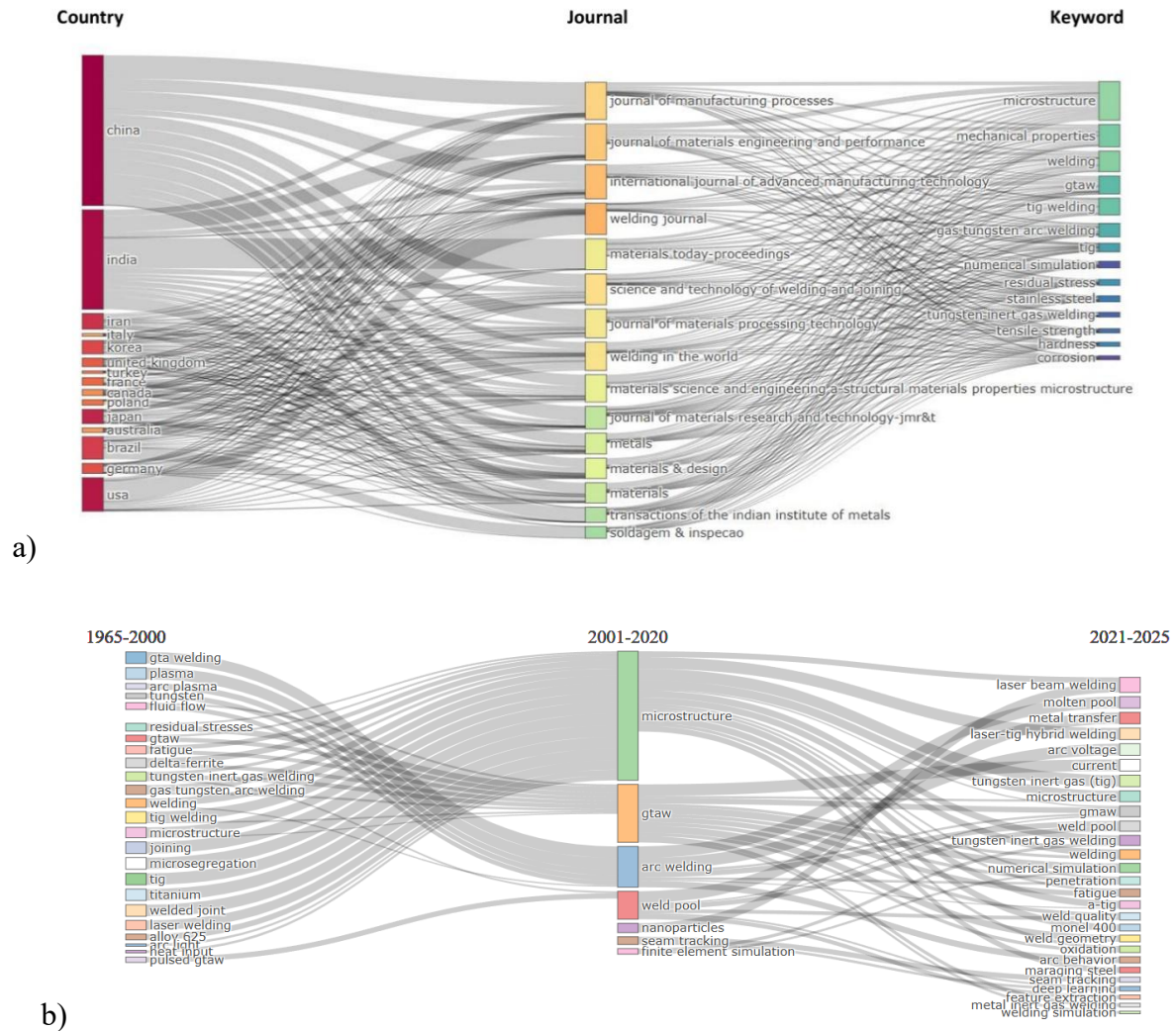


Fig. 12. Thematic development of the TIG welding: a) three-field plot of countries, journals, and keywords, b) authors' keywords time trend (Biblioshiny)

The TIG welding process follows a natural path of development, evolving from classical studies that focused on identifying the fundamental mechanisms governing the welding process and its effects on materials, to contemporary research centered on advanced materials, such as nickel-based alloys, and additive manufacturing technologies. This trend is evident across all the presented bibliometric analyses, based on keyword evaluations and the publications with the highest citation counts. Numerical simulations and automation are gaining increasing importance, particularly in applications within high-tech industries, such as the aerospace sector. The summary of the thematic evolution of the investigated process is presented in Figure 12 through three-field plots of countries, journals, and keywords and the changes in major authors' keywords over the period before and after 2000. The connection analysis presented in Figure 12a confirms observations regarding the main publication areas related to the TIG process. Research on TIG technology is primarily concentrated in Asian countries, such as India, China, and Iran, with findings mainly published in journals focusing

on manufacturing technologies and materials science. In both analyses, summarizing the studies reported in this work, a clear shift in research trends can be observed: from early investigations of fundamental process properties (arc plasma) and welded joints (microsegregation, residual stress) to more advanced research techniques, such as numerical simulations using the finite element method (FEM) and hybrid methods.

TIG welding research is largely concentrated in a small number of core journals, which serve as primary references for the field. Citation network analysis revealed three clusters of journals: one focused directly on welding and two encompassing broader areas of materials science as well as materials manufacturing and processing technologies. Changes in the prominence of individual journals (i.e., the number of papers published over a given period) are also evident, indicating shifts in the publication preferences of authors. Recently, most articles have appeared in *Materials Today: Proceedings*, *Metals*, and the *Journal of Manufacturing Processes*.

Ten leading authors have published more than 65 articles on TIG welding, and the past decade has seen a substantial increase in publication output. The average number of citations per paper remains stable (22.6–28.1), indicating that, regardless of publication intensity, these works exert a comparable impact within the scientific community. The co-authorship network is extensive, with numerous interconnections between authors. Leading research groups are centered around SB Chen, YM Zhang, M Tanaka, and Balasubramanian, who contributed earlier works, whereas the most recent publications originate from teams led by C Pandey, KD Ramkumar, and N Arivazhagan. The analysis of co-authorship further highlights the progressive globalization of research and a clear shift in activity from Western countries toward Asia and developing regions.

China is the leading contributor to TIG research funding, accounting for nearly 20% of all projects, primarily through NSFC, followed by Brazil with significant support from CNPq, state foundations, and industry. Other countries, including the United States, Europe, India, Japan, and Central Europe, provide smaller shares (generally below 6%), with funding dominated by NSF, UKRI, DST, and MEXT, while Poland and its neighbors remain below 1%.

TIG welding is a mature process with a well-established industrial position, intensively developed scientifically, featuring numerous technological variants that mitigate its drawbacks. It is versatile in many aspects while simultaneously addressing specific material and structural niches, with a promising outlook for further development. Despite the field being well-developed, there is still a need for systematic knowledge consolidation, improved availability of research data, and strengthened international and inter-institutional collaboration. Based on the results of the conducted analyses, a summary of current trends in knowledge development was presented, and future research needs were identified (Table 7).

Current research trends identified through bibliometric analyses cover both technological and material-related issues, which are often interlinked. This group of development activities includes the establishment of welding procedures and the investigation of technological and service-related properties for new grades of steels and non-ferrous metals, including dissimilar joints [190]. In particular, this concerns steels intended for operation in harsh environments: stainless steel grades and those designed for service at low and elevated temperatures as well as nickel-based alloys [191, 192]. The research focuses on the application of technological measures such as preheating, heat treatment, welding sequence optimization, as well as joint preparation methods, including variations in beveling and the

use of butter layers [193]. The TIG process holds a special position as a method used for performing the root pass in welded joints within combined welding techniques involving other welding processes [194, 195]. Progress is also being made in process development: more efficient and productive TIG welding methods are being developed, including those using activating fluxes, various hybrid process variants, hot wire and dual wire solutions, three tungsten electrodes method and external assistance such as ultrasonic vibrations or magnetic fields [196–199]. The demands of the rapidly evolving industry drive the increasingly widespread implementation of automation and robotic systems in welding, incorporating, among others, adaptive control, seam-tracking, and integrated sensor technologies [200, 201]. Furthermore, the increase in productivity and welded joints quality drives interest in arc control capabilities through the development of advanced welding power sources and process parameter regulation systems [202, 203]. Current research trends in welding increasingly involve the use of numerical simulations, particularly for the analysis and optimization of TIG processes [204]. Artificial intelligence is gaining importance by supporting process control, quality prediction, and defect detection in welded joints. The application of optimization methods, deep learning, and expert systems is also rapidly advancing, enabling greater automation and improved precision in welding operations [205, 206]. The application areas of various TIG process modifications increasingly extend into high-tech industries, including aerospace, nuclear engineering, medical device manufacturing, electronics and microelectronics, advanced automotive technologies, energy systems, and space engineering. It results from the fact that modified TIG processes provide exceptional precision, cleanliness, controlled heat input, and the capability to transition from manual operation to fully automated and robotic modes, making them ideally suited to the demanding requirements of modern high-technology industries [207–209].

Among the primary gaps in the current knowledge of TIG welding, which require intensified research efforts, are studies on the weldability of special metal alloys such as tungsten, molybdenum, tantalum, niobium, and zirconium [210–212]. In practice, the TIG process yields the best results when welding these difficult-to-weld materials, making its further development particularly necessary.

Despite the increasing number of publications on TIG welding, further systematic studies on the service performance of welded joints are still required [213]. This applies to mechanical degradation phenomena (inter alia, fatigue, creep, brittle fracture), chemical degradation phenomena (among others, uniform corrosion, pitting corrosion, intergranular corrosion), as well as coupled mechanisms, including hydrogen embrittlement [214, 215].

The reluctance of authors working on welding-related topics to publish studies in the form of data papers, as previously observed by the authors during bibliometric analyses of the FCAW welding process, is noteworthy [140]. The publication of data papers requires a significant effort, including the verification, cleaning, and detailed documentation of data, as well as ensuring their proper accessibility. Authors often express concerns regarding the loss of control over their data, the risk of misinterpretation by third parties, and the possibility of other researchers using the data for their own publications. Moreover, within the current academic evaluation system, the benefits associated with publishing data sets are limited [216–218]. Consequently, many researchers refrain from sharing their data, despite the potential advantages for scientific advancement. It is therefore essential to raise awareness among authors regarding the value of data papers and to promote open data sharing as a critical component of scientific progress.

Similarly, it should be noted that there is a lack of published results from systematic studies on the harmful effects of welding conditions on welders' health and on environmental contamination. It appears that a barrier to broader research in this area may be the difficulty in establishing collaboration between welding engineering researchers and industrial/occupational hygienists specializing in welding fumes and chemical exposure. A review of the literature indicates that such publications are produced mainly by teams that do not include welding engineers [219, 220].

A further significant limitation is the difficulty in accessing literature and tools for reliable welding cost estimation, which applies to all welding methods. Welding costs are sensitive to process conditions and parameters, making accurate estimation dependent on precise data [221].

Table 7. Current trends and key knowledge gaps in TIG welding

Trends	Knowledge gaps
<ul style="list-style-type: none"> • Research on various types of steel and non-ferrous metals • Development of alternative TIG welding variants to increase efficiency • Weldability improvement strategies for dissimilar materials, including buttering • Development of hybrid and combined welding procedures • Numerical simulations of the TIG welding process • Application of artificial intelligence • Application of optimization methods, deep learning and expert systems • Additive manufacturing using TIG welding • Applications in high-tech industries 	<ul style="list-style-type: none"> • Properties and weldability of special metals (tungsten, molybdenum, tantalum, niobium, zirconium) and their alloys • Evaluation of fatigue performance of welded joints • Environmental degradation of TIG-welded joints (corrosion, hydrogen embrittlement, microbiologically influenced corrosion, erosion, cavitation, thermal damage and high-temperature oxidation) • Limitations of applying data mining techniques to the optimization of the TIG process due to insufficient data reports • Health and safety in the TIG process • Methods for assessing welding costs

The authors have made every effort to ensure that the presented analyses and their interpretations accurately reflect the current state of knowledge, research trends, and existing knowledge gaps. However, due to methodological limitations inherent in bibliometric analyses, some inconsistencies or omissions may occur [222, 223]. The primary source of uncertainty in the presented results is the use of a single database (WOS). In addition, bibliometric analyses are quantitative in nature and do not assess the quality or reliability of publications, which is a standard feature of traditional review articles. They may also omit recent or locally published studies, do not consider methodological context, and inconsistencies in author names or affiliations can lead to errors in data aggregation. Finally, although bibliometrics allows for the identification of trends and interconnections, it only enables scientific interpretation and critical assessment of the impact of results on the development of the field to a limited extent. Nevertheless, based on systematic reviews and their own expertise, the authors consider this work to be of significant value and believe it provides an accurate representation of the historical and contemporary development of the TIG welding process, with respect to the main bibliographic dimensions of scientific output: publications, research topics, journals, authorship, countries, funding and scientific collaborations.

CONCLUSIONS

Based on the results of bibliometric analyses of 8,789 publications on TIG welding conducted using the VOSviewer 1.6.20 and Biblioshiny tools, the following basic conclusions were formulated

- The evolution of the research landscape over the 60-year publication history can be divided into three stages: an initial period of low activity, a growth phase beginning in the 1990s, and an intensive expansion after 2000. During this time, a clear shift in research focus occurred from fundamental issues (plasma arc behavior, residual stresses) toward advanced materials, additive and hybrid technologies, automation, and numerical simulations.
- A noticeable shift in research activity from Western countries to Asia can be observed, reflecting broader global trends in the welding industry. Research efforts are now concentrated primarily in Asia (China, India, Iran). Funding is dominated by China and Brazil, while the contributions of Europe, the United States, and Japan remain relatively limited.
- Publications are concentrated in a few key journals in the fields of welding, materials science, and manufacturing technology (Journal of Manufacturing Processes, Metals, and Materials Today: Proceedings). The most active authors produce consistently cited works, and co-authorship networks are increasingly extensive, although international collaboration remains limited.
- Current research directions include the application of advanced TIG variants (A-TIG, hot-wire, dual-wire, ultrasonic or magnetic field-assisted), automation and robotic welding processes, integration of sensors and adaptive control, as well as the use of artificial intelligence for joint quality optimization and diagnostics. The significant adoption of TIG welding in high-technology sectors such as aerospace, nuclear power, medical engineering, and space technology is emphasized.
- Areas still requiring in-depth study include the weldability of special metals, long-term joint durability (creep, fatigue, corrosion, hydrogen embrittlement), and the impact of TIG processes on welder health and the environment. Strengthening interdisciplinary collaboration and improving the accessibility of research data remain important challenges.
- Although TIG is a mature, industrially established process, it continues to undergo intensive development, therefore, consolidation of knowledge, better data availability, and stronger international collaboration are necessary.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Dariusz Fydrych holds the position of Deputy Editor-in-Chief of *Advances in Materials Science*, while Aleksandra Świerczyńska serves as Associate Editor of the same journal. Both have been excluded from the publication process.

REFERENCES

1. Chen B-Q, Liu K, Xu S (2024) Recent Advances in Aluminum Welding for Marine Structures. *J Mar Sci Eng* 12:1539. <https://doi.org/10.3390/jmse12091539>
2. Forest L, Thomas N, Cogneau L, et al (2021) Fabrication technologies implemented for the European test blanket modules: Status for HCPB and WCLL. *Fusion Eng Des* 164:112201. <https://doi.org/10.1016/j.fusengdes.2020.112201>
3. Sklate Boja MF, Giordana MF, Banegas S, Druker AV (2025) Twinning-Induced Plasticity Steel for the Automotive Industry: Design Stress for Gas Tungsten Arc Welded Parts. *J Mater Eng Perform* 34:3182–3196. <https://doi.org/10.1007/s11665-024-09257-1>
4. Caetano GDQ, Andrade TC, Motta MF, et al (2024) Assessment of the joint configuration and welding parameters for the dissimilar joining of AISI 304 L and AISI 410S stainless steels by friction stir welding. *Int J Adv Manuf Technol* 133:5691–5703. <https://doi.org/10.1007/s00170-024-14071-z>
5. Fydrych D, Raczko P, Świerczyńska A, et al (2023) Effect of Arc Strikes on High Strength Low Alloy Steels Welded by SMAW. *Adv Sci Technol Res J* 17:160–169. <https://doi.org/10.12913/22998624/166061>
6. Kumar K, Sharma L, Chhibber R, et al (2025) Design and development of welding electrode for structural steel. *Pract Metallogr* 62:195–211. <https://doi.org/10.1515/pm-2025-0003>
7. Colaço FHG, Turazi A, Stryhalski J, et al (2023) Wear Resistance of Fe–Cr–C Hardfacing Deposited by Flux-Core-Double-Wire GTAW in Rubber Wheel Abrasion Test. *Mater Perform Charact* 12:396–404. <https://doi.org/10.1520/MPC20220115>
8. Abbasi M, Vanani BB, Tahaei A, Garagnani GL (2024) Influence of Ni and PWHT on microstructure evolution and mechanical properties of GTA-welded duplex stainless steel and super duplex stainless steel joints: A comparative investigation. *Proc Inst Mech Eng Part J Mater Des Appl* 238:1914–1928. <https://doi.org/10.1177/14644207241236743>
9. Srivastava M, Hloch S, Krejci L, et al (2022) Utilizing the water hammer effect to enhance the mechanical properties of AISI 304 welded joints. *Int J Adv Manuf Technol* 119:2317–2328. <https://doi.org/10.1007/s00170-021-08357-9>
10. Rezende RF, Arias AR, Lima Ii EJ, Coelho FGF (2024) Manufatura Aditiva Metálica: Uma Visão Geral e Perspectivas para a Manufatura Aditiva por Deposição a Arco Baseada no Processo GMAW. *Soldag Insp* 29:e2915. <https://doi.org/10.1590/0104-9224/si29.15>
11. Ezer MA, Çam G (2022) A study on microstructure and mechanical performance of gas metal arc welded AISI 304 L joints. *Mater Werkst* 53:1043–1052. <https://doi.org/10.1002/mawe.202200050>
12. Wang C, Wang J, Bento J, et al (2023) A novel cold wire gas metal arc (CW-GMA) process for high productivity additive manufacturing. *Addit Manuf* 73:103681. <https://doi.org/10.1016/j.addma.2023.103681>
13. Şenol M, Çam G (2023) Investigation into microstructures and properties of AISI 430 ferritic steel butt joints fabricated by GMAW. *Int J Press Vessels Pip* 202:104926. <https://doi.org/10.1016/j.ijvp.2023.104926>
14. Moreno-Urbe AM, Fagundes JG, Criscuolo IL, et al (2025) Flux Filling Rate Effect on Weld Bead Deposition of Recycled Titanium Chip Tubular Wire. *Int J Precis Eng Manuf-Green Technol* 12:431–439. <https://doi.org/10.1007/s40684-024-00658-0>
15. Trembach B, Trembach I, Maliuha V, et al (2025) Study of self-shielded flux-cored wire with exothermic additions CuO-Al on weld bead morphology, microstructure, and mechanical

- properties. *Int J Adv Manuf Technol* 137:4685–4711. <https://doi.org/10.1007/s00170-025-15414-0>
16. Świerczyńska A (2025) Long-term storage of rutile flux-cored wires in shipyard environment. *Ships Offshore Struct* 1–14. <https://doi.org/10.1080/17445302.2025.2588141>
 17. Coetsee T, De Bruin F (2024) Limits on Ti Element Transfer in Submerged Arc Welding: Thermochemical Analysis. *Steel Res Int* 95:2300712. <https://doi.org/10.1002/srin.202300712>
 18. Kosturek R, Śnieżek L, Grzelak K, Wachowski M (2021) Research on the Microstructure of Laser Beam Welded Sc-Modified AA2519-F Extrusion. *Arch Metall Mater* 773–778. <https://doi.org/10.24425/amm.2022.137817>
 19. Janiczak R, Pańcikiewicz K (2021) Laser welding of austenitic ferrofluid container for the KRAKsat satellite. *Weld World* 65:1347–1357. <https://doi.org/10.1007/s40194-021-01103-5>
 20. Majkowska B, Jażdżewska M, Wołowicz E, et al (2015) The Possibility Of Use Of Laser-Modified Ti6Al4V Alloy In Friction Pairs In Endoprostheses. *Arch Metall Mater* 60:755–758. <https://doi.org/10.1515/amm-2015-0202>
 21. Klett J, Bongartz B, Wolf T, et al (2023) Plasma Welding of Aluminum in an Oxygen-Free Argon Atmosphere. *Adv Mater Sci* 23:5–18. <https://doi.org/10.2478/adms-2023-0001>
 22. Lipińska M, Pixner F, Szachogluchowicz I, et al (2023) Application of electron beam welding technique for joining coarse-grained and ultrafine-grained plates from Al-Mg-Si alloy. *J Manuf Process* 104:28–43. <https://doi.org/10.1016/j.jmapro.2023.08.057>
 23. Dziekońska M, Jonda E, Sroka M, et al (2022) Microstructure and Properties of Dissimilar Joints of AISI 430 Steel with Inconel 625 Obtained by Electron Beam Welding. *Adv Sci Technol Res J* 16:232–242. <https://doi.org/10.12913/22998624/152529>
 24. Sisodia RPS, Gáspár M, Ghosh S, Hodúlová E (2024) Investigation of the effects of beam oscillations in electron beam-welded S1100M TMCP steel. *Weld World* 68:1525–1537. <https://doi.org/10.1007/s40194-024-01765-x>
 25. Nosko O (2024) An inverse algorithm for contact heat conduction problems with an interfacial heat source based on a first-order thermocouple model. *Int Commun Heat Mass Transf* 158:107889. <https://doi.org/10.1016/j.icheatmasstransfer.2024.107889>
 26. Borhy I, Gáspár M (2025) Behaviour of resistance spot welded thermomechanically rolled high strength steel under tensile shear and cross-tension loads. *Weld World* 69:2171–2180. <https://doi.org/10.1007/s40194-025-02069-4>
 27. Morawiński Ł, Jasiński C, Goliński J, Chmielewski TM (2024) Friction welding of UFG copper using the W2Mi prototype machine. *Arch Civ Mech Eng* 24:139. <https://doi.org/10.1007/s43452-024-00955-0>
 28. Skowrońska B, Chmielewski T, Baranowski M, et al (2024) Friction weldability of ultrafine-grained titanium grade 2. *J Adv Join Process* 10:100246. <https://doi.org/10.1016/j.jajp.2024.100246>
 29. Kluz R, Bucior M, Kubit A, et al (2024) Analytical Approach for Forecasting the Load Capacity of the EN AW-7075-T6 Aluminum Alloy Joints Created Using RFSSW Technology. *Materials* 17:1529. <https://doi.org/10.3390/ma17071529>
 30. Lader SK, Baruah M, Ballav R, Bag S (2023) Recent Developments in Friction Stir Welding Tools for Weld Bead Defects Minimization – A Review. *Soldag Insp* 28:e2806. <https://doi.org/10.1590/0104-9224/si28.06>
 31. Kubit A, Derazkola HA, Jurczak W, et al (2025) Effects of process parameters on dynamic and static load capacity of EN AW-2024-T3 aluminum alloy joints prepared by friction stir welding. *Arch Civ Mech Eng* 25:153. <https://doi.org/10.1007/s43452-025-01204-8>

32. Tang Y, Li W, Zou Y, et al (2024) Effects of tool rotation direction on microstructure and mechanical properties of 6061 aluminum alloy joints by the synergistically double-sided friction stir welding. *J Manuf Process* 126:109–123. <https://doi.org/10.1016/j.jmapro.2024.07.067>
33. Kumar A, Guguloth K, Pandey SM, et al (2025) Microstructure degradation and creep failure study of the dissimilar metal welded joint of heat-resistant steel and Inconel 617 alloy tested at 650 °C and applied stress range of 100–150 MPa. *Int J Press Vessels Pip* 214:105370. <https://doi.org/10.1016/j.ijvp.2024.105370>
34. Xu Y, Liu Q, Xu J, et al (2023) Review on multi-information acquisition, defect prediction and quality control of aluminum alloy GTAW process. *J Manuf Process* 108:624–638. <https://doi.org/10.1016/j.jmapro.2023.11.025>
35. Modenesi PJ, Moreno Uribe AM (2022) Introduction to the physics of the electric arc and its application to the welding of metals, First edition. Ecoe Ediciones, Bogotá
36. Khrais S, Darabseh T, Mohammed A, Abdel Al A (2025) Investigating the Effects of H₂ Additions to Helium and Argon Shielding Gases on TIG-Welded AISI 316L Stainless Steel. *J Compos Sci* 9:199. <https://doi.org/10.3390/jcs9050199>
37. Sosnowski W, Sałaciński T (2025) Study of quality of welded joints of high-strength ferritic steel made with a cover of a mixture of argon and hydrogen. *Adv Sci Technol Res J* 19:215–222. <https://doi.org/10.12913/22998624/202414>
38. Zhang J, Shao P, Wang X, Fan D (2023) Improving weld penetration by two-TIG arc activated via mixing oxygen into shielding gas. *Int J Adv Manuf Technol* 125:169–181. <https://doi.org/10.1007/s00170-022-10703-4>
39. Varbai B, Májlínger K (2019) Physical and Theoretical Modeling of the Nitrogen Content of Duplex Stainless Steel Weld Metal: Shielding Gas Composition and Heat Input Effects. *Metals* 9:762. <https://doi.org/10.3390/met9070762>
40. Phan LH, Tashiro S, Bui HV, et al (2020) Influence of shielding gas on cathode spot behaviours in alternating current tungsten inert gas welding of aluminium. *Sci Technol Weld Join* 25:258–264. <https://doi.org/10.1080/13621718.2019.1685069>
41. Geisen O, Müller V, Graf B, Rethmeier M (2022) Integrated weld preparation designs for the joining of L-PBF and conventional components via TIG welding. *Prog Addit Manuf* 7:811–821. <https://doi.org/10.1007/s40964-021-00221-2>
42. Kojundžić D, Krnić N, Samardžić I, Konjatić P (2022) Influence of Purging Gas on 316L Stainless Steel Fusion Zone in Autogenous Stationary TIG Welding. *Teh Vjesn - Tech Gaz* 29:. <https://doi.org/10.17559/TV-20220407215830>
43. Araújo HR, Torres EA, Apolinário LHR, et al (2022) Evaluation of mechanical performance and microstructural aspects of AISI 304 stainless steel welded joints produced by controlled short circuit GMAW and GTAW. *Weld World* 66:2443–2459. <https://doi.org/10.1007/s40194-022-01383-5>
44. Sales AM, Westin EM, Colegrove P (2016) Effect of nitrogen in backing gas on duplex root weld properties of heavy-walled pipe. *Weld World* 60:877–882. <https://doi.org/10.1007/s40194-016-0347-3>
45. Aloraier A, Albannai A, Abdulsalam M, Al-Wakaa B (2025) Effect of using different backing plate materials in autogenous TIG welding on bead geometry, microhardness, tensile strength, and fracture of 1020 low carbon steel. *J Mech Behav Mater* 34:20250057. <https://doi.org/10.1515/jmbm-2025-0057>
46. Zubairuddin M, Yelamasetti B, Khan MF, et al (2025) Finite Element Method-Based Modeling of Tungsten Inert Gas Welding: Evaluating Copper Backup Plate Effects on 304L Steel. *Steel Res Int* 2500423. <https://doi.org/10.1002/srin.202500423>

47. Feng G, Dai H, Liu F, et al (2025) GTAW Repair of Near-Surface Defects in Al–Cu–Ni Nacelles Based on Ar–He Alternating Protective Gas: Mechanism of the Effect of Alternating Gas Delivery on Microstructure. *Metall Mater Trans B* 56:2317–2331. <https://doi.org/10.1007/s11663-025-03485-z>
48. Sirohi S, Kumar A, Pandey SM, et al (2023) Dissimilar autogenous TIG joint of Alloy 617 and AISI 304H steel for AUSC application. *Heliyon* 9:e19945. <https://doi.org/10.1016/j.heliyon.2023.e19945>
49. Asif H, Imran Khan M, Shehbaz T, et al (2022) Effect of welding current on the microstructure, residual stresses, mechanical properties and nano-mechanical behaviour of P-TIG welded TiNi binary shape-memory alloy. *Proc Inst Mech Eng Part J Mater Des Appl* 236:1829–1841. <https://doi.org/10.1177/14644207221085699>
50. García-García V, Reyes-Calderón F, Frasco-García OD, Alcantar-Modragón N (2022) Mechanical behavior of austenitic stainless-steel welds with variable content of δ -ferrite in the heat-affected zone. *Eng Fail Anal* 140:106618. <https://doi.org/10.1016/j.engfailanal.2022.106618>
51. Zhao Z, Lv N, Xiao R, et al (2023) Recognition of penetration states based on arc sound of interest using VGG-SE network during pulsed GTAW process. *J Manuf Process* 87:81–96. <https://doi.org/10.1016/j.jmapro.2022.12.034>
52. Horváth CM, Botzheim J, Thomessen T, Korondi P (2021) Bead geometry modeling on uneven base metal surface by fuzzy systems for multi-pass welding. *Expert Syst Appl* 186:115356. <https://doi.org/10.1016/j.eswa.2021.115356>
53. Pigozzo IO, Silva RHGE, Viviani AB (2025) A novel monitoring and characterization approach of dynamic wire feeding in GTAW process. *Weld World*. <https://doi.org/10.1007/s40194-025-01960-4>
54. Ngoc TT, Nguyen V-T, Do TT, et al (2025) Parameter Optimization of Orbital TIG Welding on Stainless Steel Pipe. *Appl Sci* 15:3227. <https://doi.org/10.3390/app15063227>
55. Baskoro AS, Widyianto A, Prasetyo E, Kiswanto G (2024) The Taguchi and Response Surface Method for Optimizing Orbital Pipe Welding Parameters in Pulsed Current Gas Tungsten Arc Welding (PC-GTAW) for SS316L. *Trans Indian Inst Met* 77:1607–1620. <https://doi.org/10.1007/s12666-023-03254-z>
56. Tang W, Proehl ER, Zhong W, et al (2025) Gas tungsten arc welding and post weld heat treatment effects on microstructure and mechanical property of castable nanostructured alloy steel. *J Nucl Mater* 613:155860. <https://doi.org/10.1016/j.jnucmat.2025.155860>
57. Manoharan T, Abdul Kadar Mohamed S, Muthuvel K, et al (2024) Subsequent welding of mild steel in the pipeline industry: mechanical, wear and microstructure characteristics. *Weld Int* 38:57–66. <https://doi.org/10.1080/09507116.2023.2288099>
58. García González J, Hernández-Ortega JJ, Jiménez-Ballesta A-E, Pedreño RZ (2021) Analysis of Tube-to-Tubesheet Welding in Carbon Steel Heat Exchangers of a Double Plate Header Box. *Materials* 15:261. <https://doi.org/10.3390/ma15010261>
59. Adin MŞ (2025) Investigation of the Influences of Welding Parameters on the Mechanical Properties of Tungsten Inert Gas Welded Dissimilar Aerospace Aluminum Alloy Joints. *J Mater Eng Perform*. <https://doi.org/10.1007/s11665-025-11377-1>
60. Vučetić F, Đorđević B, Radu D, et al (2025) Mechanical Properties of Repaired Welded Pipe Joints Made of Heat-Resistant Steel P92. *Materials* 18:2908. <https://doi.org/10.3390/ma18122908>
61. Castellanos-Gonzalez O, Sanchez Lobo E, Fydrych D, et al (2024) Operational Performance and Weld Bead Characteristics of Experimental Tubular-Wires for Underwater Welding. *Adv Sci Technol Res J* 18:433–447. <https://doi.org/10.12913/22998624/193525>

62. Tomków J, Rogalski G (2025) Behavior of API 5L X65 Pipeline Steel in Underwater Wet Welding Conditions by Applying Temper Bead Welding Technique. *Int J Press Vessels Pip* 105707. <https://doi.org/10.1016/j.ijpvp.2025.105707>
63. Hu C, Li H, Liu X, et al (2025) Investigation on microstructure and properties of the local dry underwater TIG welding of 304L stainless steel. *Mater Today Commun* 44:111978. <https://doi.org/10.1016/j.mtcomm.2025.111978>
64. Tomków J, Świerczyńska A, Landowski M, et al (2021) Bead-on-Plate Underwater Wet Welding on S700MC Steel. *Adv Sci Technol Res J* 15:288–296. <https://doi.org/10.12913/22998624/140223>
65. Anbalagan K, Ramasubramanian S, David C, et al (2023) Importance of shielding and mechanical characterization of GTAW on Ti-6AL-4V alloy sheet. *Weld Int* 37:324–333. <https://doi.org/10.1080/09507116.2023.2224929>
66. Bao Y, Sun H, Xie B, et al (2025) Prediction Model of Cavitation Accumulation Period of Duplex Stainless Steel Overlay Layer. *J Mater Eng Perform* 34:15670–15681. <https://doi.org/10.1007/s11665-024-10213-2>
67. Saffiudeen MF, Thekkuden DT, Mourad A-HI, et al (2024) Combined Gas Tungsten Arc Welding and Shielded Metal Arc Welding Processes for Joining Tube to Tubesheet in Shell and Tube Heat Exchangers. *J Press Vessel Technol* 146:044501. <https://doi.org/10.1115/1.4065519>
68. Sirohi S, Pandey SM, Świerczyńska A, et al (2022) Microstructure and Mechanical Properties of Combined GTAW and SMAW Dissimilar Welded Joints between Inconel 718 and 304L Austenitic Stainless Steel. *Metals* 13:14. <https://doi.org/10.3390/met13010014>
69. Tavares SSM, Pardal JM, Noris LF, Diniz MG (2021) Microstructural characterization and non-destructive testing and of welded joints of duplex stainless steel in flexible pipes. *J Mater Res Technol* 15:3399–3408. <https://doi.org/10.1016/j.jmrt.2021.09.087>
70. Suthar FV, Shah HN, Mandal D, Chaudhury SK (2024) Effect of alloy 625 buffer layer on corrosion resistance of nickel base hardfacing. *Surf Coat Technol* 485:130893. <https://doi.org/10.1016/j.surfcoat.2024.130893>
71. Łyczkowska K, Adamiec J (2022) The Phenomena and Criteria Determining the Cracking Susceptibility of Repair Padding Welds of the Inconel 713C Nickel Alloy. *Materials* 15:634. <https://doi.org/10.3390/ma15020634>
72. Szala M, Walczak M, Pałka T, et al (2025) Comparison of cavitation erosion and sliding wear resistance of welded CoCrWC and NiCrBSi hardfacings, AISI 316L stainless steel, and S235JR mild steel. *Adv Sci Technol Res J* 19:275–291. <https://doi.org/10.12913/22998624/209577>
73. Zhang S, Zhao H, Li Y, et al (2025) Forming mechanism of humping defects in stainless steel high-speed TIG welding. *Weld World*. <https://doi.org/10.1007/s40194-025-02037-y>
74. Serindağ HT, Çam G (2022) Multi-pass butt welding of thick AISI 316L plates by gas tungsten arc welding: Microstructural and mechanical characterization. *Int J Press Vessels Pip* 200:104842. <https://doi.org/10.1016/j.ijpvp.2022.104842>
75. Varbai B (2024) Shielding Gas Oxygen and Nitrogen Content Effects in the Case of Duplex Stainless Steel Welding. *Adv Mater Sci* 24:111–123. <https://doi.org/10.2478/adms-2024-0019>
76. Szewczyk A, Jarska R, Rogalski G (2025) Effect of heat input on distortion and morphology of tungsten inert gas welded joints in AISI 304L stainless steel. *Adv Sci Technol Res J* 19:92–104. <https://doi.org/10.12913/22998624/205997>
77. Dinaharan I, Ramesh R, Dey HC, Bhaduri AK (2022) Effect of activating flux on penetration and microstructure of tungsten inert gas-welded pure titanium grade-2 plate. *Int J Adv Manuf Technol* 121:3399–3417. <https://doi.org/10.1007/s00170-022-09542-0>

78. Bensaid N, Benlamnour MF, Laib Dit Laksir Y, et al (2024) Optimization of tungsten inert gas welding process parameters for joining austenitic stainless steel and copper using the Taguchi method. *Adv Sci Technol Res J* 19:209–219. <https://doi.org/10.12913/22998624/195449>
79. Rathore S, Kumar A, Sirohi S, et al (2024) Advanced ultra super critical power plants: role of buttering layer. *Int J Adv Manuf Technol* 134:5021–5064. <https://doi.org/10.1007/s00170-024-14469-9>
80. Frankiewicz P, Góral T, Bembenek M (2025) Influence of process parameters in tungsten inert gas welding of titanium supported by you only look once – based defect detection algorithm. *Adv Sci Technol Res J* 19:1–14. <https://doi.org/10.12913/22998624/203803>
81. Rakoczy Ł, Grudzień-Rakoczy M, Rutkowski B, et al (2023) The role of the strengthening phases on the HAZ liquation cracking in a cast Ni-based superalloy used in industrial gas turbines. *Arch Civ Mech Eng* 23:119. <https://doi.org/10.1007/s43452-023-00659-x>
82. Dai T, Feng Z, Kyle D, et al (2025) Welding investigation of a wrought FeMnAl steel for armor application. *Weld World*. <https://doi.org/10.1007/s40194-025-02078-3>
83. Hutsaylyuk V, Student O, Maruschak P, et al (2023) Analysis of Mechanical Properties of Welded Joint Metal from TPP Steam Piping after Its Operational Degradation and Hydrogenation. *Materials* 16:7520. <https://doi.org/10.3390/ma16247520>
84. Golański G, Ślania J, Sroka M, et al (2021) Microstructure and Mechanical Properties of Modern 11%Cr Heat-Resistant Steel Weld Joints. *Materials* 14:3430. <https://doi.org/10.3390/ma14123430>
85. Serindağ HT, Tardu C, Kirçiçek İÖ, Çam G (2022) A study on microstructural and mechanical properties of gas tungsten arc welded thick cryogenic 9% Ni alloy steel butt joint. *CIRP J Manuf Sci Technol* 37:1–10. <https://doi.org/10.1016/j.cirpj.2021.12.006>
86. Konat Ł, Białobrzaska B, Białek P (2017) Effect of Welding Process on Microstructural and Mechanical Characteristics of Hardox 600 Steel. *Metals* 7:349. <https://doi.org/10.3390/met7090349>
87. Jawad M, Ali A, Ishfaq K, et al (2024) Performance Evaluation of 70-30 Cu-Ni Filler Metal for Improving Dissimilar Al2024-SS304 Joints' Efficiency: A Mechanical and Microstructural Investigation. *J Mater Eng Perform* 33:10149–10164. <https://doi.org/10.1007/s11665-023-08659-x>
88. Ioannidou D, Foinikaridis M, Deligiannis S, Tsakiridis PE (2023) Microstructural Evaluation of Inconel 718 and AISI 304L Dissimilar TIG Joints. *Metals* 14:54. <https://doi.org/10.3390/met14010054>
89. Łastowska O, Starosta R, Jabłońska M, Kubit A (2024) Exploring the Potential Application of an Innovative Post-Weld Finishing Method in Butt-Welded Joints of Stainless Steels and Aluminum Alloys. *Materials* 17:1780. <https://doi.org/10.3390/ma17081780>
90. Serindağ HT, Çam G (2023) Characterizations of Microstructure and Properties of Dissimilar AISI 316L/9Ni Low-Alloy Cryogenic Steel Joints Fabricated by Gas Tungsten Arc Welding. *J Mater Eng Perform* 32:7039–7049. <https://doi.org/10.1007/s11665-022-07601-x>
91. Gajjar PK, Khatri BC, Jha R (2024) Investigation of effect of post weld heat treatment on microhardness and microstructure of auto TIG welded stabilized SA213 TP347H weldments. *Weld Int* 38:366–382. <https://doi.org/10.1080/09507116.2024.2342340>
92. Xiao X, Liu Q, Hu M, et al (2021) Effect of Welding Sequence and the Transverse Geometry of the Weld Overlay on the Distribution of Residual Stress in the Weld Overlay Repair of T23 Tubes. *Metals* 11:568. <https://doi.org/10.3390/met11040568>
93. Kumar A, Pandey SM, Sirohi S, et al (2023) P92 steel and inconel 617 alloy welds joint produced using ERNiCr-3 filler with GTAW process: Solidification mechanism, microstructure,

- mechanical properties and residual stresses. *Heliyon* 9:e18959. <https://doi.org/10.1016/j.heliyon.2023.e18959>
94. Serindağ HT, Çam G (2021) Microstructure and mechanical properties of gas metal arc welded AISI 430/AISI 304 dissimilar stainless steels butt joints. *J Phys Conf Ser* 1777:012047. <https://doi.org/10.1088/1742-6596/1777/1/012047>
95. Rakoczy Ł, Grudzień-Rakoczy M, Rutkowski B, et al (2024) The role of the microstructural changes during induction preheating on the HAZ liquation cracking susceptibility of Ni-based superalloy. *J Mater Sci* 59:631–649. <https://doi.org/10.1007/s10853-023-09184-x>
96. González-González C, Los Santos-Ortega J, Fraile-García E, Ferreiro-Cabello J (2023) Environmental and Economic Analyses of TIG, MIG, MAG and SMAW Welding Processes. *Metals* 13:1094. <https://doi.org/10.3390/met13061094>
97. Quecke E, Galarneau J-M, Cherry N, et al (2025) Particle size distribution of welding fume variations by process, base material, and consumable. *Weld World*. <https://doi.org/10.1007/s40194-025-01995-7>
98. Kővágó C, Szekeres B, Szűcs-Somlyó É, et al (2022) Preliminary study to investigate the distribution and effects of certain metals after inhalation of welding fumes in mice. *Environ Sci Pollut Res* 29:49147–49160. <https://doi.org/10.1007/s11356-022-19234-7>
99. Bricín D, Kříž A, Jansa Z, et al (2024) Evaluation of Structure and Properties of COR 13/4 (GX4CrNi13-4) Tungsten Inert Gas-Welded Steel. *J Mater Eng Perform*. <https://doi.org/10.1007/s11665-024-10478-7>
100. Kumar R, Sirohi S (2025) Microstructure and Mechanical Behavior Study of the GTAW Joint of AISI 310 and Modified 9Cr-1Mo (P91) Steel. *J Mater Eng Perform*. <https://doi.org/10.1007/s11665-025-10820-7>
101. Huang X, Qi H, Li S, et al (2025) Fatigue behavior of welded joints of a Ni–Fe-based superalloy. *Weld World* 69:657–669. <https://doi.org/10.1007/s40194-024-01909-z>
102. Silva EMFS, Aota LS, Corrêa SR, et al (2025) Role of δ -ferrite and α' -martensite transformation on the fatigue crack growth rate of 316L austenitic stainless steel welded by Tungsten Inert Gas process. *Mater Sci Eng A* 927:148040. <https://doi.org/10.1016/j.msea.2025.148040>
103. Bao Y, Wei S, Liu Y, et al (2024) Effect of Co on the corrosion resistance and erosion-corrosion behavior of duplex stainless steel surfacing layer. *Weld World* 68:2985–2994. <https://doi.org/10.1007/s40194-023-01619-y>
104. Yadav AK, Agrawal MKr, Saxena KK, Yelamasetti B (2024) Effect of GTAW process parameters on weld characteristics and microstructural studies of dissimilar welded joints of AA5083 and AA6082: optimization technique. *Int J Interact Des Manuf IJIDeM* 18:1151–1160. <https://doi.org/10.1007/s12008-023-01230-x>
105. Prabu SS, Muthu SM, Sujai S, et al (2023) Failure Assessment and High-Temperature Corrosion Behavior of Inconel 625 Welds in Simulated K₂SO₄ + 60% NaCl Boiler Environment. *J Mater Eng Perform* 32:11024–11039. <https://doi.org/10.1007/s11665-023-07923-4>
106. Surkar HS, Kumar A, Sirohi S, et al (2024) A dissimilar welded joint of grade 92 steel and AISI 304L steel obtained using IN82 buttering and IN617 filler: relationship of microstructure and mechanical properties. *Arch Civ Mech Eng* 24:109. <https://doi.org/10.1007/s43452-024-00920-x>
107. Suthar FV, Shah H, Mandal D, Chaudhury SK (2025) Elevated-temperature wear performance of NiCr-B hardfacing alloy deposited on 316L stainless steel via GTAW process. *Weld World*. <https://doi.org/10.1007/s40194-025-01970-2>
108. Jamrozik W, Górka J, Kik T (2021) Temperature-Based Prediction of Joint Hardness in TIG Welding of Inconel 600, 625 and 718 Nickel Superalloys. *Materials* 14:442. <https://doi.org/10.3390/ma14020442>

109. Wang J, Li C, Yang B, et al (2025) Melting pool visualization and penetration prediction study of TIG bottoming welding with narrow gap hot wire. *J Manuf Process* 133:226–237. <https://doi.org/10.1016/j.jmapro.2024.11.055>
110. Kulawik A, Wróbel J, Tagowski M (2025) Precision control of surface heating temperature in TIG-based thermal treatment. *Int Commun Heat Mass Transf* 161:108513. <https://doi.org/10.1016/j.icheatmasstransfer.2024.108513>
111. Yelamasetti B, Devi BTL, Omprakash B, et al (2025) Exploring the synergistic mechanisms of mechanical, microstructural morphology, and corrosion characteristics in inconel 718-AISI 430 dissimilar weldment joints using ERNiCrMo-4 and ER2209 fillers: a comparative performance analysis. *Arch Civ Mech Eng* 25:98. <https://doi.org/10.1007/s43452-025-01155-0>
112. Kumar A, Singhal A, Sirohi S, et al (2025) Pulsed current GTAW Inconel 625/AISI 304 L steel dissimilar joint: Microstructure and mechanical properties. *J Constr Steel Res* 231:109602. <https://doi.org/10.1016/j.jcsr.2025.109602>
113. Sirohi S, Kumar A, Singh M, et al (2025) Pulsed GTAW joint of P92 steel and Inconel 625: microstructure and mechanical properties. *Arch Civ Mech Eng* 25:. <https://doi.org/10.1007/s43452-025-01153-2>
114. Bhanu V, Fydrych D, Pandey SM, et al (2024) Activated Tungsten Inert Gas Weld Characteristics of P91 Joint for Advanced Ultra Supercritical Power Plant Applications. *J Mater Eng Perform* 33:12070–12082. <https://doi.org/10.1007/s11665-023-08814-4>
115. Singh SR, Khanna P (2024) Investigation of A-TIG welded duplex stainless-steel plates. *Int J Interact Des Manuf IJIDeM* 18:2225–2235. <https://doi.org/10.1007/s12008-022-01104-8>
116. Minh PS, Nguyen V-T, Do TT, et al (2023) Parameter Optimization in Orbital TIG Welding of SUS 304 Stainless Steel Pipe. *Metals* 14:5. <https://doi.org/10.3390/met14010005>
117. Arunkumar V, Jerome S, Vasantharaja P, Vasudevan M (2025) Study of Microstructure, Mechanical Properties and SCC Resistance of HSLA Steel for Naval Applications. *Trans Indian Inst Met* 78:175. <https://doi.org/10.1007/s12666-025-03601-2>
118. Wang Y, Liu P, Fan H, et al (2023) Microstructure and Mechanical Properties of Thick 08Cr9W3Co3VNbCuBN Heat-Resistant Steel welded Joint by TIP TIG Welding. *Mater Res* 26:e20220370. <https://doi.org/10.1590/1980-5373-mr-2022-0370>
119. Zmitrowicz P, Kawiak M, Kochmański P, Baranowska J (2021) Microstructure and Mechanical Properties of Welded Joints of 1.4462 Duplex Steel Made by the K-TIG Method. *Materials* 14:7868. <https://doi.org/10.3390/ma14247868>
120. Wang J, Shi Y, Cui Y, Wang Z (2022) Investigation of the relationship between voltage and arc length of K-TIG welding under penetrated condition. *Int J Adv Manuf Technol* 120:3843–3857. <https://doi.org/10.1007/s00170-022-09008-3>
121. Silva RHGE, Schwedersky MB, Rosa ÁFD (2020) Evaluation of toptig technology applied to robotic orbital welding of 304L pipes. *Int J Press Vessels Pip* 188:104229. <https://doi.org/10.1016/j.ijpvp.2020.104229>
122. Liu L, Yang H, Tao X, Cheng Z (2024) Study on the coupling characteristics of laser-TIG hybrid heat source with different offsets. *Int J Adv Manuf Technol* 134:2337–2351. <https://doi.org/10.1007/s00170-024-14180-9>
123. Videira AM, Mendes WR, Ventrella VA, Calliari I (2023) Increasing the Corrosion Resistance in the UNS S32750 Super Duplex Steel Welded Joints through Hybrid GTAW-Laser Welding and Nitrogen. *Materials* 16:543. <https://doi.org/10.3390/ma16020543>
124. Zou J, Cai J, Zou X, et al (2026) Selective visual observation of the contraction behavior of arc plasma during fiber laser-TIG hybrid welding. *Opt Lasers Eng* 196:109423. <https://doi.org/10.1016/j.optlaseng.2025.109423>

125. Abima CS, Madushele N, Mwema FM, Akinlabi SA (2024) Experimental and finite element simulation for thermal distribution in TIG, MIG and TIG-MIG hybrid welds. *Int J Interact Des Manuf IJIDeM* 18:1171–1181. <https://doi.org/10.1007/s12008-022-01173-9>
126. Zhang S, Zhao H, Li Y, et al (2025) TIG-based hybrid arc welding: a review. *Int J Adv Manuf Technol* 139:1105–1121. <https://doi.org/10.1007/s00170-025-15833-z>
127. Zhou W, Yue J, Zhou H, Li H (2025) Microstructure, tensile property and corrosion performance of GTAW 316 L/Q345 under compound-magnetic field. *J Constr Steel Res* 228:109468. <https://doi.org/10.1016/j.jcsr.2025.109468>
128. Li W, Jia C, Gao Y, et al (2025) Arc change mechanism in Ultrasonic-Magnetic field coaxial hybrid GTAW. *Int J Mech Sci* 299:110407. <https://doi.org/10.1016/j.ijmecsci.2025.110407>
129. Zhou W, Yue J, Zhong P, et al (2024) Investigation on weld forming, microstructure and mechanical characteristics of dissimilar steel GTAW under novel composite magnetic field. *Int J Press Vessels Pip* 209:105177. <https://doi.org/10.1016/j.ijpvp.2024.105177>
130. Kumar MDB, Arivazhagan N, Tofil S, et al (2024) Influence of pulsed current GTAW-WAAM process parameters on the single layer bead geometry and multi bead multi-layer deposition of a nickel-based superalloy. *Mater Today Commun* 39:108824. <https://doi.org/10.1016/j.mtcomm.2024.108824>
131. Antonello MG, Bracarense AQ, Scheuer CJ, De Freitas Daudt N (2021) Effect of electromagnetic arc constriction applied in GTAW-based wire arc additive manufacturing on walls' geometry and microstructure. *J Manuf Process* 71:156–167. <https://doi.org/10.1016/j.jmapro.2021.09.015>
132. Rathinasuriyan C, Elumalai P, Bharani Chandar J, et al (2023) Welding-based additive manufacturing processes for fabrication of metallic parts. *Compos Adv Mater* 32:26349833231210572. <https://doi.org/10.1177/26349833231210572>
133. Toaldo PH, Ferreira ASF, Verastégui RN, Pukasiewicz AGM (2024) Evaluation of the Processing Parameters Influence on the Additive Manufacturing of VP50IM Steel by PCGTAW. *Soldag Insp* 29:e2901. <https://doi.org/10.1590/0104-9224/si29.01>
134. Simion G, Mirza-Rosca J, Voiculescu I, Scutelnicu E (2024) Corrosion behaviour of medium entropy alloy deposited on low carbon steel substrate by innovative welding method. *J Mater Res Technol* 33:7136–7146. <https://doi.org/10.1016/j.jmrt.2024.11.082>
135. Kołodziejczak P, Bober M, Chmielewski T (2022) Wear Resistance Comparison Research of High-Alloy Protective Coatings for Power Industry Prepared by Means of CMT Cladding. *Appl Sci* 12:4568. <https://doi.org/10.3390/app12094568>
136. Liu Y, He H (2023) Scientometrics of Scientometrics Based on Web of Science Core Collection Data between 1992 and 2020. *Information* 14:637. <https://doi.org/10.3390/info14120637>
137. Ji C, Sheng R, Wu H, et al (2024) Bibliometric analysis and research trends in minimum quantity lubrication for reducing cutting forces. *Int J Adv Manuf Technol* 135:4995–5033. <https://doi.org/10.1007/s00170-024-14793-0>
138. Kwidzińska DB, Jażdżewska M, Fydrych D (2025) The influence of selected metal oxides and laser modification on the surfaces of titanium alloys – Bibliometric and systematic review. *Opt Laser Technol* 184:112592. <https://doi.org/10.1016/j.optlastec.2025.112592>
139. Vergara D, Fernández-Arias P, Ariza-Echeverri EA, Del Bosque A (2025) Residual Stresses in Metal Manufacturing: A Bibliometric Review. *Materials* 18:3612. <https://doi.org/10.3390/ma18153612>
140. Świerczyńska A, Varbai B, Pandey C, Fydrych D (2024) Exploring the trends in flux-cored arc welding: scientometric analysis approach. *Int J Adv Manuf Technol* 130:87–110. <https://doi.org/10.1007/s00170-023-12682-6>

141. Van Eck NJ, Waltman L (2017) Citation-based clustering of publications using CitNetExplorer and VOSviewer. *Scientometrics* 111:1053–1070. <https://doi.org/10.1007/s11192-017-2300-7>
142. Ahmed MMZ, El-Sayed Seleman MM, Fydrych D, Çam G (2023) Review on friction stir welding of dissimilar magnesium and aluminum alloys: Scientometric analysis and strategies for achieving high-quality joints. *J Magnes Alloys* 11:4082–4127. <https://doi.org/10.1016/j.jma.2023.09.039>
143. Aria M, Cuccurullo C (2017) bibliometrix: An R-tool for comprehensive science mapping analysis. *J Informetr* 11:959–975. <https://doi.org/10.1016/j.joi.2017.08.007>
144. Gerasimov I, Kc B, Mehrabian A, et al (2024) Comparison of datasets citation coverage in Google Scholar, Web of Science, Scopus, Crossref, and DataCite. *Scientometrics* 129:3681–3704. <https://doi.org/10.1007/s11192-024-05073-5>
145. Romanelli JP, Gonçalves MCP, De Abreu Pestana LF, et al (2021) Four challenges when conducting bibliometric reviews and how to deal with them. *Environ Sci Pollut Res* 28:60448–60458. <https://doi.org/10.1007/s11356-021-16420-x>
146. Zhao H, Zhang S, Chen H, et al (2024) Methods to Improve TIG Welding Efficiency. *Trans Indian Inst Met* 77:2231–2245. <https://doi.org/10.1007/s12666-024-03323-x>
147. Zhao H, Zhang S, Yu X, et al (2024) Research status of insufficient sidewalls penetration in narrow gap TIG welding of thick metal plates. *Int J Adv Manuf Technol* 134:39–56. <https://doi.org/10.1007/s00170-024-14204-4>
148. Wu S, Gong S, Gao H (2019) Arc characteristics of GTAW under high pressure. *Sādhanā* 44:70. <https://doi.org/10.1007/s12046-019-1053-9>
149. Singh G, Dewangan AK, Khan MF, Moinuddin SQ (2025) Fundamental review on gas tungsten arc welding of magnesium alloys: challenges, innovations, and future perspectives. *Weld World* 69:2767–2787. <https://doi.org/10.1007/s40194-025-02047-w>
150. Kumar N, Pandey C, Kumar P (2023) Dissimilar Welding of Inconel Alloys With Austenitic Stainless-Steel: A Review. *J Press Vessel Technol* 145:011506. <https://doi.org/10.1115/1.4055329>
151. Zwicker MFR, Moghadam M, Zhang W, Nielsen CV (2020) Automotive battery pack manufacturing – a review of battery to tab joining. *J Adv Join Process* 1:100017. <https://doi.org/10.1016/j.jajp.2020.100017>
152. Xu F, Xu Y, Zhang H, Chen S (2022) Application of sensing technology in intelligent robotic arc welding: A review. *J Manuf Process* 79:854–880. <https://doi.org/10.1016/j.jmapro.2022.05.029>
153. Saboori A, Aversa A, Marchese G, et al (2019) Application of Directed Energy Deposition-Based Additive Manufacturing in Repair. *Appl Sci* 9:3316. <https://doi.org/10.3390/app9163316>
154. Eren B, Demir MH, Mistikoglu S (2023) Recent developments in computer vision and artificial intelligence aided intelligent robotic welding applications. *Int J Adv Manuf Technol* 126:4763–4809. <https://doi.org/10.1007/s00170-023-11456-4>
155. Abima CS, Madushele N (2025) Analysis of TIG-MIG Hybrid Welding and Its Impact on Mechanical and Microstructural Integrity: A Comprehensive Review. *Rev Compos Matér Avancés* 35:197–205. <https://doi.org/10.18280/rcma.350201>
156. Mondal H (2025) A Technical Note on Bibliometric Analysis by Biblioshiny and VOSviewer. *Indian J Radiol Imaging* s-0045-1810060. <https://doi.org/10.1055/s-0045-1810060>
157. Sugiana D, Hafiar H, Amin K, et al (2025) Music in communication: a bibliometric review. *Cogent Soc Sci* 11:2450292. <https://doi.org/10.1080/23311886.2025.2450292>

158. Xiao Y, Deng H, Wang P, Xu J (2025) Exploring green mining research trends through web of science: A bibliometric analysis based on VOSviewer and CiteSpace. *Sustain Environ* 11:2505288. <https://doi.org/10.1080/27658511.2025.2505288>
159. Kumar B, Bhattacharya TK, Modak N, Halder P (2025) State of Art and Bibliometric Analysis of Alumina Cutting Tool Using Computer Vision. *Trans Indian Ceram Soc* 84:117–131. <https://doi.org/10.1080/0371750X.2025.2482986>
160. Souza AM, Silva EJD, Ratay J, Yamaguchi H (2022) Magnetic field-assisted finishing processes: from bibliometric analysis to future trends. *J Braz Soc Mech Sci Eng* 44:327. <https://doi.org/10.1007/s40430-022-03641-5>
161. Qu HJ, Wharry JP (2022) Crystallographic orientation data from chloride-induced stress corrosion crack (CISCC) paths in gas tungsten arc welded (GTAW) austenitic stainless steel 304L. *Data Brief* 42:108059. <https://doi.org/10.1016/j.dib.2022.108059>
162. Omoniyi P, Mahamood M, Jen T-C, Akinlabi E (2021) TIG welding of Ti6Al4V alloy: Microstructure, fractography, tensile and microhardness data. *Data Brief* 38:107274. <https://doi.org/10.1016/j.dib.2021.107274>
163. Tannous M, Bologna F, Stefanini C (2020) Load cell torques and force data collection during tele-operated robotic gas tungsten arc welding in presence of collisions. *Data Brief* 31:105981. <https://doi.org/10.1016/j.dib.2020.105981>
164. Giner-Miguel J, Gómez A, Cabot J (2025) On the Readiness of Scientific Data Papers for a Fair and Transparent Use in Machine Learning. *Sci Data* 12:61. <https://doi.org/10.1038/s41597-025-04402-4>
165. Stahlschmidt S, Stephen D (2022) From indexation policies through citation networks to normalized citation impacts: Web of Science, Scopus, and Dimensions as varying resonance chambers. *Scientometrics* 127:2413–2431. <https://doi.org/10.1007/s11192-022-04309-6>
166. Sjögarde P, Didegah F (2022) The association between topic growth and citation impact of research publications. *Scientometrics* 127:1903–1921. <https://doi.org/10.1007/s11192-022-04293-x>
167. Ogunleye B, Lancho Barrantes BS, Zakariyyah KI (2025) Topic modelling through the bibliometrics lens and its technique. *Artif Intell Rev* 58:74. <https://doi.org/10.1007/s10462-024-11011-x>
168. Brandão AA, Tavares SSM, Breves IMS, et al (2023) Análise Comparativa dos Processos TIG e Eletrodo Revestido Aplicados a Soldagem em Operação em Dutos de Aço ao Carbono para Linhas de Distribuição de Gás. *Soldag Insp* 28:e2808. <https://doi.org/10.1590/0104-9224/si28.08>
169. Sirohi S, Kumar N, Kumar A, et al (2023) Metallurgical characterization and high-temperature tensile failure of Inconel 617 alloy welded by GTAW and SMAW—a comparative study. *Proc Inst Mech Eng Part J Mater Des Appl* 237:2046–2067. <https://doi.org/10.1177/14644207231171266>
170. Yu Q, Zhang W, Shang J, et al (2024) Comparative investigation on the microstructure and corrosion properties of surfacing cobalt alloys by various methods. *Surf Coat Technol* 494:131386. <https://doi.org/10.1016/j.surfcoat.2024.131386>
171. Yelamasetti B, Sridevi M, Sree NS, et al (2025) Comparative Studies on Mechanical Properties and Microstructural Changes of AA5052 and AA6082 Dissimilar Weldments Developed by TIG, MIG, and FSW Techniques. *J Mater Eng Perform* 34:9972–9985. <https://doi.org/10.1007/s11665-024-09867-9>
172. Richter T, Erxleben K, Rhode M, et al (2024) Microstructure characterization of dissimilar metal welds of innovative high- and medium-entropy alloys to austenitic stainless steels joint by

- tungsten inert gas and friction stir welding. *Weld World* 68:557–565. <https://doi.org/10.1007/s40194-023-01618-z>
173. Milčić M, Klobčar D, Milčić D, et al (2024) Comparison between Mechanical Properties and Joint Performance of AA 2024-T351 Aluminum Alloy Welded by Friction Stir Welding, Metal Inert Gas and Tungsten Inert Gas Processes. *Materials* 17:3336. <https://doi.org/10.3390/ma17133336>
174. Yaduwanshi DK, Rao CRM, Naidu SCVRM, et al (2024) Thermal evaluation of aluminum welding: a comparative study of friction stir welding (FSW), plasma-fsw, and tungsten inert gas (TIG)-FSW techniques. *Int J Interact Des Manuf IJIDeM* 18:5501–5513. <https://doi.org/10.1007/s12008-024-01796-0>
175. Guo Z-J, Shi J, Chang J-H, et al (2026) Impact of different welding processes on the pneumatic bulge test at a high temperature: Gas Tungsten Arc Welding and Laser Beam Welding. *Int J Press Vessels Pip* 219:105703. <https://doi.org/10.1016/j.ijpvp.2025.105703>
176. Adin MŞ (2024) A parametric study on the mechanical properties of MIG and TIG welded dissimilar steel joints. *J Adhes Sci Technol* 38:115–138. <https://doi.org/10.1080/01694243.2023.2221391>
177. Çelik BE, Talaş Ş (2024) Mechanical Properties of UNS S31803 (2205) Duplex SS Welds Deposited with GTAW and SMAW Methods. *Soldag Insp* 29:e2913. <https://doi.org/10.1590/0104-9224/si29.13>
178. Damar S, Koksalmis GH (2024) A bibliometric analysis of metaverse technologies in healthcare services. *Serv Bus* 18:223–254. <https://doi.org/10.1007/s11628-024-00553-3>
179. Parvanda R, Kala P (2023) Trends, opportunities, and challenges in the integration of the additive manufacturing with Industry 4.0. *Prog Addit Manuf* 8:587–614. <https://doi.org/10.1007/s40964-022-00351-1>
180. Baufeld B, Biest OVD, Gault R (2010) Additive manufacturing of Ti–6Al–4V components by shaped metal deposition: Microstructure and mechanical properties. *Mater Des* 31:S106–S111. <https://doi.org/10.1016/j.matdes.2009.11.032>
181. Dinovitzer M, Chen X, Laliberte J, et al (2019) Effect of wire and arc additive manufacturing (WAAM) process parameters on bead geometry and microstructure. *Addit Manuf* 26:138–146. <https://doi.org/10.1016/j.addma.2018.12.013>
182. Muthupandi V, Bala Srinivasan P, Seshadri SK, Sundaresan S (2003) Effect of weld metal chemistry and heat input on the structure and properties of duplex stainless steel welds. *Mater Sci Eng A* 358:9–16. [https://doi.org/10.1016/S0921-5093\(03\)00077-7](https://doi.org/10.1016/S0921-5093(03)00077-7)
183. Henderson MB, Arrell D, Larsson R, et al (2004) Nickel based superalloy welding practices for industrial gas turbine applications. *Sci Technol Weld Join* 9:13–21. <https://doi.org/10.1179/136217104225017099>
184. Verma J, Taiwade RV (2017) Effect of welding processes and conditions on the microstructure, mechanical properties and corrosion resistance of duplex stainless steel weldments—A review. *J Manuf Process* 25:134–152. <https://doi.org/10.1016/j.jmapro.2016.11.003>
185. Tedersoo L, Küngas R, Oras E, et al (2021) Data sharing practices and data availability upon request differ across scientific disciplines. *Sci Data* 8:192. <https://doi.org/10.1038/s41597-021-00981-0>
186. Velez-Estevez A, García-Sánchez P, Moral-Munoz JA, Cobo MJ (2022) Why do papers from international collaborations get more citations? A bibliometric analysis of Library and Information Science papers. *Scientometrics* 127:7517–7555. <https://doi.org/10.1007/s11192-022-04486-4>

187. Vieira ES (2023) The influence of research collaboration on citation impact: the countries in the European Innovation Scoreboard. *Scientometrics* 128:3555–3579. <https://doi.org/10.1007/s11192-023-04715-4>
188. Aksnes DW, Sivertsen G (2023) Global trends in international research collaboration, 1980–2021. *J Data Inf Sci* 8:26–42. <https://doi.org/10.2478/jdis-2023-0015>
189. Pepe CGE, Fonseca MVA, Silva Marques CF (2024) International collaboration towards innovation management: a network perspective and the Global Innovation Index. *J Innov Entrep* 13:32. <https://doi.org/10.1186/s13731-024-00384-6>
190. Junek M, Svobodova M, Horvath J, Mara V (2022) The Effect of Long-Term Ageing on Microstructural Properties and Laves Phase Precipitation of Welded P91 and P92 Steels. *Steel Res Int* 93:2100311. <https://doi.org/10.1002/srin.202100311>
191. Warchoń P, Tuz L (2025) Welding Technology and Heat Treatment Butt-Welded Joints of Thin-Walled Inconel 718 Alloy Tubes. *Materials* 18:3896. <https://doi.org/10.3390/ma18163896>
192. Szczucka-Lasota B, Węgrzyn T (2022) Improvement Of The Mechanical Properties Of Mobile Platform Stainless Construction Elements. *Transp Probl* 17:91–102. <https://doi.org/10.20858/tp.2022.17.4.08>
193. Mehdi H, Singh B, Salah AN, et al (2024) Effect of PWHT on metallurgical and mechanical characterization of dissimilar welded joint of P91 and P92 steels. *J Adhes Sci Technol* 38:1395–1412. <https://doi.org/10.1080/01694243.2023.2265224>
194. Devakumaran K, Rajamurugan G, Ghosh PK (2025) Importance of Narrow Gap in Pulsed Current Gas Metal Arc Welding of Thick Wall Micro-alloyed Steel: Weld Appearance and Microstructure. *J Mater Eng Perform* 34:805–823. <https://doi.org/10.1007/s11665-023-09033-7>
195. Cai L, Zhao L, Song K, et al (2026) Microstructural evolution, creep damage mechanism and failure risk of P92 steel welded joints after long-term service. *Int J Press Vessels Pip* 219:105677. <https://doi.org/10.1016/j.ijpvp.2025.105677>
196. Théodore J, Girault B, Couturier L, et al (2025) Investigation of the residual stresses and strains, microstructure and mechanical properties of stainless steel multipass welds produced using dual wire-tungsten inert gas process. *Materialia* 40:102403. <https://doi.org/10.1016/j.mtla.2025.102403>
197. Ranjan R, Cep R, Kumar A, et al (2025) Comprehensive review of vibration-assisted welding processes: Mechanisms, applications, and future directions. *Front Mech Eng* 11:1550928. <https://doi.org/10.3389/fmech.2025.1550928>
198. He Y, Song X, Yang Z, et al (2025) Research and Development Progress of Laser–Arc Hybrid Welding: A Review. *Metals* 15:326. <https://doi.org/10.3390/met15030326>
199. Schwedersky MB, Da Rosa ÁF, Souza MDA, Silva RHGE (2025) Arc characteristic of multi-cathode three-electrode GTAW (TE-GTAW). *Weld World* 69:2609–2617. <https://doi.org/10.1007/s40194-024-01887-2>
200. Wang W, Shi Y, Li C, et al (2025) Passive vision-based wire-filling weaving GTAW weld seam tracking. *Weld World* 69:1219–1228. <https://doi.org/10.1007/s40194-025-01939-1>
201. Von Querfurth B, Belhout S-E, Knaak C, et al (2025) AI-driven autonomous adaptive feedback welding machine. *Weld World* 69:1419–1426. <https://doi.org/10.1007/s40194-024-01898-z>
202. Wu J, Wang Z, Zhu Z, et al (2023) Effect of Fast-Frequency Pulsed Current Parameters on FFP-TIG arc Behavior and Its Implications for Inconel 718 Welding. *Metals* 13:848. <https://doi.org/10.3390/met13050848>
203. Wang Z, Jiang D, Wu J, Xu M (2020) A review on high-frequency pulsed arc welding. *J Manuf Process* 60:503–519. <https://doi.org/10.1016/j.jmapro.2020.10.054>

204. Zubairuddin M, Pradeep GVK, Shaikh JH, et al (2025) Predictive Modeling of Activated Tungsten Inert Gas Welding in Grade 91 Steel Using Finite Element Method and Experimental Techniques. *Steel Res Int* 96:266–275. <https://doi.org/10.1002/srin.202500072>
205. Nohwal A, Patel N, Aravindan S, Jha S (2025) Deep learning for automated defect recognition in tungsten inert gas welds of stainless steel 304. *Measurement* 253:117850. <https://doi.org/10.1016/j.measurement.2025.117850>
206. Boucetta B, Boumediene F, Ait Chikh MA, Afia A (2025) An improved artificial neural network using weighted mean of vectors algorithm for precise GTAW weld quality prediction and parameter optimization. *Int J Adv Manuf Technol* 139:4173–4197. <https://doi.org/10.1007/s00170-025-16128-z>
207. Ali R, El-Betar A, Magdy M (2024) A review on optimization of autonomous welding parameters for robotics applications. *Int J Adv Manuf Technol* 134:5065–5086. <https://doi.org/10.1007/s00170-024-14396-9>
208. Wang Y, Tang Z, Xu K, et al (2025) The arc design principles and mechanism analysis of pumping gas hollow tungsten negative pressure arc welding or additive manufacturing. *J Manuf Process* 149:364–382. <https://doi.org/10.1016/j.jmapro.2025.05.075>
209. Jeon J-Y, Oh C-Y, Kim CK (2025) Analysis of variables in finite element analysis for multi-pass welding in nuclear power plant components, part 1: Comprehensive study with experimental validation using scientific weld specimen. *Nucl Eng Technol* 57:103275. <https://doi.org/10.1016/j.net.2024.10.037>
210. Sai MT, Nguyen TD, Nguyen AX, et al (2025) Influence of Heat Treatment on the Microstructure of TIG Welding Between Ti–6Al–4V and Ti–CP. *Trans Indian Inst Met* 78:245. <https://doi.org/10.1007/s12666-025-03730-8>
211. Munusamy V, Raju G, Veeman D, Subramaniyan MK (2025) Tungsten inert gas welding of zircaloy sheet: Mechanical properties and microstructural characterization. *Mater Werkst* 56:193–200. <https://doi.org/10.1002/mawe.202400141>
212. Bernardo Sánchez A, Presno Vélez Á, Fernández-Columbié T, et al (2022) Tantalum Alloy Welding: Does the Thermal Cycle Influence the Microstructure? *Appl Sci* 12:1440. <https://doi.org/10.3390/app12031440>
213. Li C, Zhai H, Liu Q, et al (2025) Realizing long-term structural stability in stainless steel butt-welded joints of vacuum vessel via incremental creep effect. *Vacuum* 233:114031. <https://doi.org/10.1016/j.vacuum.2025.114031>
214. Yelamasetti B, Phani Sushma IS, Radha KK, et al (2025) Investigation of thermal fields, residual stresses, and tensile strength of dissimilar weldments of AA5052-AA7075 alloys on the stress corrosion cracking: Comparative analysis of coolant effects for enhancing weld integrity. *J Mater Res Technol* 38:6315–6326. <https://doi.org/10.1016/j.jmrt.2025.09.032>
215. Xu M, Huang X, Li S, et al (2024) Effects of random meso-defects on fatigue behavior of welded joints: Damage evolution and lifetime prediction. *Fatigue Fract Eng Mater Struct* 47:3619–3632. <https://doi.org/10.1111/ffe.14390>
216. Jiao C, Darch PT (2020) The role of the data paper in scholarly communication. *Proc Assoc Inf Sci Technol* 57:e316. <https://doi.org/10.1002/pras.2.316>
217. Thanos C (2017) Research Data Reusability: Conceptual Foundations, Barriers and Enabling Technologies. *Publications* 5:2. <https://doi.org/10.3390/publications5010002>
218. Jiao H, Qiu Y, Ma X, Yang B (2024) Dissemination effect of data papers on scientific datasets. *J Assoc Inf Sci Technol* 75:115–131. <https://doi.org/10.1002/asi.24843>

219. Graczyk H, Lewinski N, Zhao J, et al (2015) Increase in oxidative stress levels following welding fume inhalation: a controlled human exposure study. *Part Fibre Toxicol* 13:31. <https://doi.org/10.1186/s12989-016-0143-7>
220. Sjögren B, Albin M, Broberg K, et al (2022) An occupational exposure limit for welding fumes is urgently needed. *Scand J Work Environ Health* 48:1–3. <https://doi.org/10.5271/sjweh.4002>
221. Negrin I, Kripka M, Yepes V (2025) Manufacturing cost optimization of welded steel plate I-girders integrating hybrid construction and tapered geometry. *Int J Adv Manuf Technol* 140:1601–1624. <https://doi.org/10.1007/s00170-025-16365-2>
222. Xie H, Wang S, Niu D, et al (2024) A bibliometric analysis of the research landscape on vascular normalization in cancer. *Heliyon* 10:e29199. <https://doi.org/10.1016/j.heliyon.2024.e29199>
223. Öztürk O, Kocaman R, Kanbach DK (2024) How to design bibliometric research: an overview and a framework proposal. *Rev Manag Sci* 18:3333–3361. <https://doi.org/10.1007/s11846-024-00738-0>



DSPACE

<https://dspace.org/>

Tungsten inert gas welding research trends: a 60-year bibliometric analysis using Vosviewer and Biblioshiny

Fydrych, Dariusz; wierczyska, Aleksandra; Varbai, Balázs; Wilk, Kamil; Suder, Wojciech ...

2025-12

Gdansk University of Technology

<https://doi.org/10.2478/adms-2025-0019>

Fydrych D, wierczyska A, Varbai B, et al., (2025) Tungsten inert gas welding research trends: a 60-year bibliometric analysis using Vosviewer and Biblioshiny. *Advances in Materials Science*, Volume 25, Issue 4, December 2025, pp. 5-46