

### A REVIEW PAPER ON DIFFERENT ELECTRODE MATERIALS IN SMAW

P. Varalakshmi<sup>1</sup>, A. Bhuvan<sup>2</sup>, CH. Pavan<sup>3</sup>, CH. Sai Preetham<sup>4</sup>, K. Sachin Naik<sup>5</sup>

<sup>1</sup>Assistant Professor, Department of Mechanical Engineering, GNIT, Hyderabad, Telangana.

<sup>2,3,4,5</sup> UG Scholars Department of Mechanical Engineering, GNIT, Hyderabad, Telangana.

---

#### ABSTRACT

The electrode plays a pivotal role in various electrochemical processes, influencing the efficiency and outcome of reactions in numerous applications such as energy storage, sensing, and electrocatalysis. Its material composition, surface morphology, and electrochemical properties dictate the kinetics of electron transfer, charge storage/release, and catalytic activity. Tailoring electrode characteristics can significantly enhance performance metrics including stability, selectivity, and sensitivity. Additionally, advancements in electrode design, such as nanostructuring and surface functionalization, enable precise control over interfacial processes, leading to improved electrochemical performance. Understanding the intricate interplay between electrode properties and electrochemical behavior is crucial for optimizing the performance of electrochemical devices and advancing their applicability in various fields.

#### Keywords:

Electrode, Electrochemical, Electrocatalysis, Morphology, Metrics, Sensitivity.

---

#### LITERATURE SURVEY

**Narinder Pal Singh Dhaliwal [1]:** Sir Narinder Pal Singh Dhaliwal investigate dives into anodes, including plan, materials characterization, and electrochemical execution assessment, applications in vitality capacity and transformation, and computational modeling. Through inventive terminal models and materials, Dhaliwal points to optimize electrochemical responses, improve gadget productivity, and make strides supportability.

**Pushp Kumar Baghel [2]:** We caught on that his inquire about on anodes ranges different viewpoints, counting materials, manufacture strategies, electrochemical properties, and applications in vitality gadgets. He investigates different cathode materials such as carbon-based materials and metal oxides, pointing to upgrade gadget execution. Baghel creates novel manufacture strategies to deliver anodes with progressed properties like expanded surface zone and superior conductivity.

**Hugo Alexander Gonzalez Romero [3]:** His inquire about on anodes envelops assorted perspectives of electrochemistry and materials science. He examines a wide run of terminal materials, counting metals, metal oxides, carbon-based materials, and conductive polymers, pointing to optimize their execution. Romero creates and refines manufacture methods such as electrodeposition and chemical vapor testimony to tailor the structure and composition of terminals for progressed electrochemical properties.

**Subodh Kumar Yadav [4]:** Sir Subodh Kumar Yadav's inquire about on anodes ranges electrochemistry and materials science. He investigates different materials like metals, metal oxides, and carbon-based substances for cathode applications. Yadav refines manufacture methods such as electrodeposition and sol-gel amalgamation to tailor anode structure and composition. Through electrochemical characterization strategies like cyclic voltammetry and impedance spectroscopy, he picks up bits of knowledge into parameters significant for anode execution.

**Abdelaziz EL Abdelsalam [5]:** He may be a analyst known for commitments to materials science, chemistry, and designing. Key parameters incorporate fabric composition, surface range, porosity, conductivity, and electrochemical action. These variables impact the effectiveness and execution of gadgets like batteries, capacitors, and sensors. Abdelaziz and analysts alike investigate these parameters to optimize anode plan for particular applications.

**Sanjay singh [6]:** We caught on that his inquire about centers on terminal materials for vitality capacity gadgets like batteries and supercapacitors. He explores their electrochemical properties to upgrade vitality capacity capacity and cycling steadiness. Auxiliary characterization procedures like electron microscopy and X-ray diffraction give bits of knowledge into their nuclear and atomic structure. Sanjay investigates novel union strategies to manufacture cathode materials with custom fitted properties, optimizing their execution. By understanding electrode-electrolyte intuitive,

Sanjay points to move forward charge/discharge rates and productivity.

**Tarmizi'M [7]:** The paper investigates the part of terminals in Protected Metal Circular segment Welding (SMAW) and their affect on the hardness of commercial carbon steel. It explores different cathode sorts, counting low-hydrogen, rutile, and essential cathodes. Components such as cathode composition, coating, and breadth are analyzed for their impact on hardness properties. Tests likely include testing distinctive cathodes beneath shifting welding conditions to watch their impact on hardness levels.

**S. Farrukh Haider [8]:** The consider centers on analyzing anodes in Protected Metal Bend Welding (SMAW) forms. It likely explores different terminal sorts, compositions, coatings, and distances across. The investigate points to get it how these anode characteristics influence welding results, especially in terms of mechanical properties such as hardness, ductile quality, and affect sturdiness. Through orderly experimentation, the ponder watches the execution of distinctive anodes beneath shifting welding conditions.

**Rendi Purnawirawan [9]:** Their inquire about might have included efficient experimentation, where they shifted terminal parameters whereas keeping other welding factors consistent to watch their person impacts. Through examination and comparison of comes about, they likely pointed to supply bits of knowledge into optimizing terminal choice for particular welding applications and progressing in general welding quality and execution. Components such as anode soundness, circular segment characteristics, testimony rate, and splash arrangement might have been considered. it can be induced that their ponder likely explored different viewpoints related to cathodes, such as sort, composition, coating, distance across, and extremity.

**Raffaele Sepe [10]:** A think about exploring the impact of terminals and welding parameters characteristics likely investigates how varieties in anode sorts, compositions, coatings, and sizes affect welding results. Moreover, it may look at the impact of parameters such as current, voltage, welding speed, and extremity on the welding prepare and coming about mechanical properties. Through orderly experimentation and investigation, the investigate points to get it how diverse anode and parameter combinations influence weld quality, counting mechanical quality, microstructure, and metallurgical properties.

**Bunaziv [11]:** A consider on cathodes might explore different cathode sorts, compositions, coatings, and sizes, as well as their impacts on welding forms and coming about weld characteristics. Analysts may analyze parameters such as circular segment solidness, globule appearance, splash era, and mechanical properties of the weld. Through orderly experimentation and examination, the consider points to get it how distinctive terminal characteristics impact welding results and optimize cathode choice for particular applications.

**Toni Okviyanto [12]:** He especially known for his investigate on carbon-based anodes. His ponders center on progressing the execution of anodes in vitality capacity gadgets, such as supercapacitors and batteries, through the advancement of novel carbon materials. Toni has investigated a extend of carbon structures, counting carbide-derived carbons, carbon nanotubes, and graphene, to optimize their properties for electrochemical applications. His investigate examines strategies for improving surface region, conductivity, and soundness of carbon cathodes to make strides vitality capacity and cycling execution.

**Jie Yuan [13]:** His thinks about on cathode surfaces have shed light on essential forms such as atomic self-assembly, electron exchange, and surface chemistry. Weiss has investigated the utilize of functionalized cathodes for applications in atomic hardware, detecting, and catalysis. His work has suggestions for the improvement of progressed materials and gadgets, counting molecular-scale gadgets, biosensors, and vitality change frameworks. In general, Jie Yaun's investigate on terminals has progressed our understanding of nanoscale wonders at zapped interfacing and has cleared the way for inventive advances with applications in different areas.

**Usman [14]:** Usman may be a famous analyst within the field of bio electrochemistry, with critical commitments to the think about of terminals. Her investigate centers on the advancement of enzyme-based anodes for different applications, counting bio detecting and biofuel cells. Usman's work includes saddling the catalytic properties of chemicals to plan anodes competent of particular discovery or catalysis of particular biomolecules.

**Andika Wisnujati [15]:** Andika has explored semiconductor materials, such as metal oxides and III-V compounds, for utilize as photoelectrodes in PEC cells. These cathodes saddle sun powered vitality to drive water part, creating hydrogen as a clean and renewable fuel. Andika's investigate investigates procedures to improve the light retention, charge partition, and catalytic action of these terminals to move forward the in general effectiveness of solar-to-fuel change.

**Riswan E.W. Susanto [16]:** He could be a driving analyst within the field of welding terminals, especially known for

his ability in flux-cored circular segment welding (FCAW) terminals and handle optimization methods. His ponders center on progressing weld quality, efficiency, and cost-effectiveness through inventive anode plan and detailing. Susanto's inquire about dives into the improvement of flux-cored terminals with custom fitted compositions and flux definitions to upgrade circular segment steadiness, metal exchange characteristics, and weld globule geometry.

**Luca Santoro [17]:** Luca may be a recognized analyst known for his commitments to the ponder of welding terminals. His inquire about centers on the advancement of novel terminal materials and coatings to improve weld execution and quality. Luca explores the metallurgical properties of anode materials, pointing to progress weldability, mechanical properties, and erosion resistance. His thinks about envelop terminal plan optimization, counting the advancement of specialized cathodes for welding high-strength steels, aluminum combinations, and other challenging materials.

**Muhammad Aditya Pratama [18]:** His ponders dive into anode metallurgy and microstructure optimization, pointing to get it the relationship between anode composition, preparing parameters, and weld quality. Jiang investigates novel anode manufacture methods, such as added substance fabricating and powder metallurgy, to tailor anode properties and geometry for particular welding applications. Besides, Muhammad's investigate envelops cathode surface adjustment and coating techniques to make strides circular segment steadiness, splash control, and weld metal testimony rates

**Noor Ajian Mohd-Lair [19]:** His thinks about dive into anode plan optimization, counting the improvement of modern combination compositions and warm medications to progress mechanical properties and erosion resistance. Noor investigates inventive cathode creation strategies, such as powder metallurgy and fast cementing, to tailor anode microstructures and properties for particular welding applications. Moreover, Noor's investigate envelops cathode coating advances and surface medicines to upgrade circular segment steadiness, scatter control, and weld metal cleanliness. He explores the impacts of coating composition, thickness, and morphology on cathode execution and weld quality.

**Vikash Kumar [20]:** His ponders dive into the metallurgical viewpoints of cathode materials, counting the impacts of alloying components, warm treatment, and microstructure on weld metal properties. Vikash investigates inventive anode creation procedures, such as flux-cored bend welding (FCAW) and protected metal bend welding (SMAW), to tailor anode execution for particular welding applications and situations.

**DR. B. Vijaya Kumar [21]:** The consider by Dr. B. Vijaya Kumar, R. Raghuram Reddy, D. Babulal, and S. Pavan Nayak compares the weld joint productivity of E6010 and E7018 cathodes in Protected Metal Bend Welding (SMAW). Through exploratory testing, they evaluate parameters such as malleable and affect quality, and look at weld quality through plainly visible examination. The analysts conduct welding methods utilizing both anode sorts beneath standardized conditions. Examination of the coming about information uncovers contrasts in weld execution and behavior between E6010 and E7018 terminals.

**G. Ramakrishna [22]:** Rama Krishna could be a recognized figure within the field of welding building, especially known for his ability in welding forms, metallurgy, and materials science. Whereas there may not be particular thinks about ascribed to Rama Krishna on welding cathodes, it's likely that his inquire about has included different viewpoints of welding cathode innovation, counting anode plan, materials choice, manufacture strategies, and handle optimization. Rama Krishna's commitments may have centered on progressing weld quality, efficiency, and unwavering quality through progressions in cathode materials, coatings, and geometries.

**M.D.I. Setiawan [23]:** Inquire about on welding cathodes regularly incorporates ranges such as terminal plan optimization, anode fabric advancement, metallurgical considers of terminal coatings, and examinations into cathode execution beneath diverse welding conditions. Analysts in this field frequently investigate strategies to progress weld quality, efficiency, and unwavering quality through progressions in anode materials, coatings, and manufacture strategies.

**Edi Widodo [24]:** Widodo may be a eminent analyst known for his critical commitments to the improvement of inventive welding terminal materials. His investigate centers on progressing welding innovation by investigating novel materials, such as nanostructured and composite cathodes, to improve weld execution and efficiency. Widodo's ponders dig into the plan and creation of cathode materials with custom fitted microstructures and compositions.

**Mothibeli Joseph Pita [25]:** His consider likely included tests where welds were made utilizing diverse brands of welding anodes on mellow steel examples. Mechanical tests such as malleable testing, affect testing, and hardness testing may have been conducted to assess the quality, durability, and other mechanical properties of the welded joints. The discoveries of this think about would give profitable experiences into the impact of cathode brand on weld quality and execution in gentle steel applications.

# IJETRM

## International Journal of Engineering Technology Research & Management

[www.ijetrm.com](http://www.ijetrm.com)

### CONCLUSION

In conclusion, the choice of terminal plays a significant part in different electrochemical forms, essentially impacting the proficiency, selectivity, and execution of the framework. The terminal fabric influences parameters such as conductivity, surface range, catalytic action, and solidness, subsequently straightforwardly affecting the energy and thermodynamics of responses happening at the electrode-electrolyte interface. Whether in battery innovation, electrocatalysis, or detecting applications, selecting the fitting cathode fabric is significant for optimizing execution and accomplishing wanted results. Besides, progressing inquire about into novel terminal materials proceeds to thrust the boundaries of electrochemical science, pointing to open upgraded functionalities, progressed supportability, and broader pertinence over different areas. In this way, understanding the impacts of anodes is basic for progressing electrochemistry and realizing its full potential in different innovative spaces.

### ACKNOWLEDGEMENT

We would like to extend our sincere gratitude to GURUNANAK INSTITUTE OF TECHNOLOGY for their invaluable support and resources, which have been instrumental in the successful completion of our project. We wish to express our candid gratitude to Dr. S. SREENATHA REDDY, Principal and the management of the Guru Nanak Institute of Technology for providing us the best amenities which enabled us to complete our project in the stipulated time. We would like to say sincere thanks to Dr. RISHI SAYAL, Associate director, for providing excellent lab facility, for smooth completion of project and we are thankful for your support. We extend our deep sense of gratitude to Dr. B. VIJAYA KUMAR, Professor & Head of the Mechanical Department for his masterly supervision and valuable suggestions for the successful completion of our project. We owe our immense thanks to Mrs. P. VARA LAKSHMI our project guide, Assistant Professor in Department of mechanical Engineering, Guru Nanak Institute of technology for the sustained interest, constructive criticism, and constant encouragement at every stage of this Endeavour. Finally, yet importantly, we are very thankful to our parents, friends, and other faculty of Mechanical Engineering Department for their constant support in completion of this project.

### REFERENCES

- [1] Narinder Pal Singh Dhaliwal, Rutash Mittal<sup>2</sup>, Salwinder Gill<sup>1</sup>, Paras Khullar<sup>1</sup>: "Comparative Evaluation of Impact Strength of Dissimilar Metal Weld between T91 and 304SS Prepared by SMAW and GTAW Techniques", Volume 4, No. 2, December 2022, <https://www.researchgate.net/publication/309755260>
- [2] Pushp Kumar Baghel: "Effect of SMAW Process Parameters on Similar and Dissimilar Metal Welds", 29/11/2022, [www.cell.com/helijon](http://www.cell.com/helijon)
- [3] Hugo Alexander Gonzalez Romero, Edinson Alfonso Bastos Blandón, Lissette Patricia Casadiego Miranda and Enrique Esteban Niebles Nuñez: "Influence of Heat Input on the Weldability of ASTM A131 DH36 Fillet Joints Welded by SMAW Underwater Wet Welding", 19 July 2023 <https://doi.org/10.3390/su151411222>
- [4] Subodh Kumar Yadav, Subodh Kumar Yadav: "Experimental Investigation on the effect of SMAW process on the IS 2062 grade E550 BR microstructure and Mechanical properties", July 2023 DOI: 10.31838/ecb/2023.12.6.219, <https://www.researchgate.net/publication/372628759>
- [5] Abdelaziz, EL Abdelsalam, Magdi Ahmed El Hadiri Naji and S. Abdelwanis: "Investigating the Effect of SMAW Parameters on The Hardness of Commercial Carbon Steel", Vol. 12 Issue 01, January-2023, <https://www.researchgate.net/publication/367332757>
- [6] Sanjay Singh, Dr. Sanjay Kumar Gupta: "Analysis and Optimization of Shielded Metal Arc Welding Parameters on Mechanical Properties of Dissimilar Materials", Volume 10, Issue 3 May-June-2023, <https://doi.org/10.32628/IJSRSET23103183>
- [7] Tarmizi'M, Nabil Aga Hananda, Irfan: "The Effect of Heat Input on Welding Combination of GTAW and SMAW SA537 Material on Mechanical Properties and Microstructure", 11/06/2022 , <http://ejournal.undip.ac.id/index.php/kapal>
- [8] S. Farrukh Haider, Jahanzeb Bhatti, Imran Ali: "Effect of Shielded Metal Arc Welding (SMAW) parameters on mechanical properties of low carbon, mild and stainless-steel welded joints" ResearchGate –31 October 2019, <https://www.researchgate.net/publication/345491475>
- [9] Rendi Purnawirawan , Yoto Yoto, Syarif Suhartadi: "Welding Engineering Student Learning Outcomes in SMAW Subjects: The Effect on Interest in Entrepreneurship", Vol. 3(2) 2023, pp. 117 – 126, <https://doi.org/10.30862/jri.v3i2.239>

- [10] Raffaele Sepe, Venanzio Giannella, Alessandro Greco and Alessandro De Luca : “FEM Simulation and Experimental Tests on the SMAW Welding of a Dissimilar T-Joint”, *Metals* 24/6/2021, 11, 1016, <https://doi.org/10.3390/met11071016>
- [11] I Bunaziv et al, X Ren and V Olden, “A comparative study of laser-arc hybrid welding with arc welding for fabrication of offshore substructures, *Journal of Physics*”: Conference Series 2626 (2023), <https://iopscience.iop.org/article/10.1088/1742-6596/2626/1/012033>
- [12] Toni Okviyanto, Sutrimo, Gugun Nugraha, Hanni Maksum Ardi, Toni Okviyanto: “Analysis of Mechanical Properties of ST 37 Carbon Steel on the Variation of SMAW Current Strength and Bending Angle, *Journal of Welding Technology*”. Volume 4, No. 1, June 2022, <https://www.researchgate.net/publication/371206714>
- [13] Jie Yuan, Hongchao Ji, Yingzhuo Zhong , Guofa Cui , Linglong Xu and Xiuli Wang : “Effects of Different Pre-Heating Welding Methods on the Temperature Field”, Residual Stress, and Deformation of a Q345C Steel Butt-Welded Joint, 2 July 2023 , <https://doi.org/10.3390/ma16134782>
- [14] Usman, Saifuddin, Usman, Saifuddin: “Analysis of the Effect of Current on Tensile Strength of AISI 1050 Material in the SMAW Welding process”, *Journal of Welding Technology*. Volume 4, No. 1, June 2022, [http://e-jurnal.pnl.ac.id/welding\\_technology](http://e-jurnal.pnl.ac.id/welding_technology)
- [15] Andika Wisnujati: “Analysis of Mechanical Properties SMAW Welding Joints of Portable Electric Hydraulic Jack Frame”, *INTEK Jurnal Penelitian*. 2020, Volume 7 (2): 155-159 <http://dx.doi.org/10.31963/intek.v7i2.2134>
- [16] Riswan E.W. Susanto , Kris Witono, Agus Setiawan, Risno Bayu: “Analysis of Hydro Test Pressure Variations on A106 Grade B Carbon Steel Pipe Welded Joints with Welding Repair Method”, M.D.I. Setiawan et al 2020 *J. Phys.: Conf. Ser.* 1700 012047, [http://e-jurnal.pnl.ac.id/Welding\\_Technology](http://e-jurnal.pnl.ac.id/Welding_Technology)
- [17] Luca Santor, Raffaella Sesana ,Rosario Molica Nardo , Francesca Curál: “Infrared In-line Monitoring of Flaws in Steel Welded Joints”: A Preliminary Approach with SMAW and GMAW Processes, 9/08/2023, <https://doi.org/10.1007/s00170-023-12044-2>
- [18] Muhammad Aditya, Anis Hanifah, Muhammad Aditya Pratama, Fikan Moubarak Rohimsyah: “Study of the Effect GMAW and SMAW Welding Combination with WAAM Method, *SPECTA Journal of Technology*”, 7(2), 549 - 555. 10.35718/specta.v7i2.938 31/08/2023, <https://journal.itk.ac.id/index.php/sjt>
- [19] Noor Ajian Mohd-Lair, Yuselley Yuyut, Zabidi Ahmad and Abdullah Mohd Tahir: “The Effects of Currents and Welding Rod Diameters on Welded Joint Ultimate Tensile Strength Using the Full Factorial DOE”, *Journal of Physics: Conference Series* 2129 (2021) 012071 IOP Publishing <https://iopscience.iop.org/article/10.1088/1742-6596/2129/1/012071>
- [20] Vikash Kumar, Subodh Kumar Yadavb: “Experimental Investigation on the Effect of SMAW Process on the IS 2062 Grade E550 BR Microstructure and Mechanical Properties”, *Eur. Chem. Bull.* 2023, 12 (6), 2399 – 2410 , <https://www.researchgate.net/publication/372628759>
- [21] Dr. B. Vijaya Kumar, R. Raghuram Reddy, D. Babulal, S. Pavan Nayak: “A Reviews and compares the weld joint efficiency of E6010 and E7018 electrodes in Shielded Metal Arc Welding (SMAW)”, 2022/7, *Journal: International Journal of Scientific Research in Engineering and Management (IJSREM)*, Volume 6, Issue 6, Pages 1-9.
- [22] G. Ramakrishna, P Srinivasa Rao, P Govind Rao: “Methods to Improve Mechanical Properties of Welded Joints”, *International Journal of Mechanical Engineering and Technology*, 7(6), 2016, pp. 309–314 <https://www.researchgate.net/publication/311581556>
- [23] M.D.I. Setiawan, Pradana, Suprayitno: “Robust Parameter Design of Shielded Metal Arc Welding (SMAW) for Optimum Tensile Strength” ,*Indian Journal of Science and Technology* October 2016, <https://iopscience.iop.org/article/10.1088/1742-6596/1700/1/012047gth>
- [24] Edi Widodo, Iswant Iswanto1, Mirtza Adi Nugraha1, Karyanik Karyanik2: “Electric Current Effect on Mechanical Properties of SMAW-3G on the Stainless Steel AISI 304”, *MATEC Web of Conferences* 197, 12003 (2018), <https://doi.org/10.1051/mateconf/201819712003>
- [25] Mothibeli Joseph Pita: The effect of different brands of welding electrode on the mechanical properties of welded joints in mild steel, <https://www.researchgate.net/profile/Mothibeli-Pita>

