

Indian Journal of Modern Research and Reviews

This Journal is a member of the 'Committee on Publication Ethics'

Online ISSN:2584-184X



Research Article

Plasma: The Fourth State of Matter and Its Applications in Modern Medicine with Special Reference to Cancer Treatment

Jyoti Mulkhede

TGT, Sri Vamshidhar High School, Green Homes Colony, Nadergul Village, Balapur Mandal, Hyderabad, Telangana, India

Corresponding Author: * Jyoti Mulkhede

DOI: <https://doi.org/10.5281/zenodo.20595457>

Abstract

Plasma, widely recognised as the fourth state of matter, is an ionized gas composed of free electrons, ions, and neutral particles that exhibit unique electrical and chemical properties. Unlike solids, liquids, and gases, plasma demonstrates collective behaviour due to its charged particles, making it highly responsive to electromagnetic fields. In recent years, plasma has gained significant attention in the field of medicine, particularly in sterilisation, wound healing, and cancer treatment. This study explores the fundamental nature of plasma and its growing role in modern healthcare, with a special focus on cold plasma applications in oncology. Traditional cancer treatments such as chemotherapy and radiation therapy often cause severe side effects, including damage to healthy cells, immune suppression, and prolonged recovery time. Cold atmospheric plasma (CAP) has emerged as a promising alternative due to its ability to generate reactive oxygen and nitrogen species (ROS/RNS), which selectively target cancer cells while minimising harm to surrounding healthy tissues. This paper is based on a literature review of textbooks, research journals, and scientific articles. Findings suggest that plasma technology enhances antimicrobial activity, promotes faster tissue regeneration, and shows potential in selective cancer cell destruction through apoptosis. Plasma medicine represents a safe, innovative, and efficient approach to future healthcare systems.

Manuscript Information

- ISSN No: 2584-184X
- Received: 04-04-2026
- Accepted: 03-06-2026
- Published: 08-06-2026
- MRR:4(6); 2026: 40-42
- ©2026, All Rights Reserved
- Plagiarism Checked: Yes
- Peer Review Process: Yes

How to Cite this Article

Mulkhede J. Plasma: The Fourth State of Matter and Its Applications in Modern Medicine with Special Reference to Cancer Treatment. Indian J Mod Res Rev. 2026;4(6):40-42.

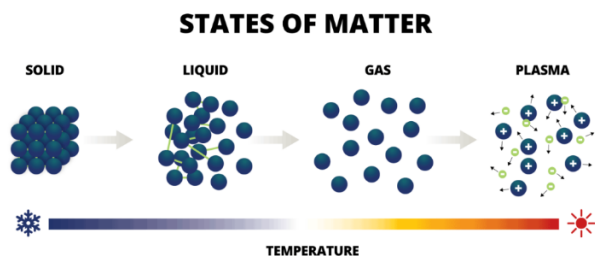
Access this Article Online



www.mrrjournal.in

KEYWORDS: Plasma, cold plasma, cancer treatment, ionised gas, reactive oxygen species, plasma medicine, biomedical applications.

1. INTRODUCTION



Plasma is an ionized state of matter consisting of electrons, ions, and neutral particles. It is considered the fourth state of matter after solid, liquid, and gas. Ionisation occurs when sufficient energy is supplied to remove electrons from atoms. Plasma is naturally found in the Sun, lightning, and auroras, while artificial plasma exists in fluorescent lamps and medical devices. Cold plasma operates at near-room temperature and is safe for biological tissues, making it useful in wound healing, sterilisation, and cancer therapy.

2. MATERIALS AND METHODS

This study is based on a literature review using textbooks, IEEE journals, WHO reports, and online databases like Google Scholar and ScienceDirect.

3. METHODOLOGY

1. Collection of scientific literature
2. Study of plasma formation
3. Analysis of medical applications
4. Comparison of chemotherapy vs plasma therapy

Plasma types include thermal and cold plasma. Cold plasma is widely used in medical applications.

4. RESULTS

- Plasma shows strong antimicrobial properties
- Cold plasma enhances wound healing
- Cancer cells are sensitive to oxidative stress
- Plasma induces apoptosis in cancer cells
- Reduces dependency on antibiotics

TABLES

Table 1: Comparison of States of Matter

Property	Solid	Liquid	Gas	Plasma
Shape	Fixed	Variable	Variable	Variable
Volume	Fixed	Fixed	Variable	Variable
Charged Particles	No	No	No	Yes

Table 2: Natural Sources of Plasma

Source	Example
Stellar Plasma	Sun
Atmospheric Plasma	Lightning
Space Plasma	Aurora

Table 3: Types of Medical Plasma

Type	Temperature	Application
Thermal Plasma	High	Industrial
Cold Plasma	Low	Medical

Table 4: Plasma Generation Methods

Method	Application
DBD	Skin treatment
Plasma Jet	Wound healing
Corona Discharge	Sterilization
Microwave Plasma	Research

Table 5: Plasma Reactive Species

Species	Function
ROS	Cell damage
RNS	Signaling and apoptosis

Table 6: Medical Applications of Plasma

Application	Benefit
Sterilization	Infection control
Wound Healing	Faster recovery
Surgery	Reduced bleeding
Cancer Therapy	Tumor destruction

Table 7. Comparison with Chemotherapy

Parameter	Chemotherapy	Cold Plasma
Side Effects	High	Lower
Selectivity	Moderate	Higher
Systemic Toxicity	High	Low

5. DISCUSSION

Cold atmospheric plasma produces reactive oxygen and nitrogen species that interact with biological tissues. In cancer treatment, it induces oxidative stress, leading to selective cancer cell death while sparing healthy cells. Mechanisms include DNA damage, mitochondrial dysfunction, and apoptosis activation. Limitations include a lack of standardised clinical protocols and the need for further trials.

6. CONCLUSION

Plasma, the fourth state of matter, is a revolutionary development in science and medicine. Its ability to generate reactive species allows it to interact with biological systems in unique ways. This study highlights the strong potential of cold plasma in cancer treatment, sterilisation, and wound healing. Cold plasma selectively targets cancer cells through oxidative stress mechanisms while minimising damage to healthy tissues. This makes it a promising alternative to chemotherapy and radiation therapy. It also shows strong antimicrobial activity and promotes tissue regeneration, leading to faster recovery. However, further research and clinical trials are necessary before widespread medical use. In conclusion, plasma medicine offers a safe, efficient, and innovative approach to future healthcare systems.

ACKNOWLEDGEMENTS

The author thanks Sri Vamshidhar High School for academic support and guidance. Gratitude is extended to science teachers and the reference materials used in this study.

CONFLICT OF INTEREST

The author declares no conflict of interest.

REFERENCES

1. Fridman A. *Plasma medicine*. Hoboken (NJ): Wiley; 2013.
2. IEEE Transactions on Plasma Science. New York (NY): Institute of Electrical and Electronics Engineers; 1973–present.
3. World Health Organization. *Decontamination and reprocessing of medical devices for health-care facilities*. Geneva: WHO; 2016.
4. Google Scholar. Google Scholar database. Mountain View (CA): Google LLC; 2004–present.
5. ScienceDirect. Amsterdam: Elsevier; 1997–present.
6. *Journal of Physics D: Applied Physics*. Bristol (UK): IOP Publishing; 1968–present.
7. *Nature Reviews Cancer*. London (UK): Nature Publishing Group; 2001–present.
8. American Physical Society. APS publications. College Park (MD): American Physical Society; 1899–present.
9. *Clinical Plasma Medicine*. Amsterdam: Elsevier; 2014–2021.
10. Halliday D, Resnick R, Walker J. *Fundamentals of Physics*. 10th ed. Hoboken (NJ): Wiley; 2014.

Creative Commons License

This article is an open-access article distributed under the terms and conditions of the Creative Commons Attribution–Non-commercial–No Derivatives 4.0 International (CC BY-NC-ND 4.0) License. This license permits users to copy and redistribute the material in any medium or format for non-commercial purposes only, provided that appropriate credit is given to the original author(s) and the source. No modifications, adaptations, or derivative works are permitted.

About the Corresponding Author

Jyoti Mulkhede is a TGT at Sri Vamshidhar High School, Hyderabad, Telangana, India. She is dedicated to school education and student development, with a focus on effective teaching practices, academic excellence, and holistic learning in the secondary education sector.