ASEC 2024 Conference

The 5th International Electronic Conference on Applied Sciences

04–06 December 2024 | Online

MDPI

The Development of an Affordable Graphite-Based Conductive Ink for Printed Electronics

Anandita Dey *, Ankur Jyoti Kalita, Hiramoni Khatun and Utpal Sarma

Department of Instrumentation and USIC, Gauhati University

INTRODUCTION & AIM

- Printed electronics (PE) are rapidly growing, especially in wearable sensors, smart textiles, and IoT devices, offering advantages such as lightweight, cost-effective production, and durability
- PE uses fabrication techniques like inkjet, flexographic or screen printing for depositing electrically conductive patterns on various substrates
- The conductive inks used in PE must be highly conductive, cost-effective, biocompatible, easy to prepare, and less viscous
- The three main components of a conductive ink includes a conducting material (like silver, gold, copper, or carbon-based materials), a binder agent and a solvent
- Metallic-based conductive inks generally exhibit superior electrical conductivity but tend to be more expensive compared to carbon-based alternatives
- The abundant availability of high-purity graphite, coupled with the environmental sustainability, cost-efficiency, and non-flammability of water, makes this combination highly suitable for the formulation of biocompatible, low-cost, and easily synthesizable conductive inks

- The current work proposes the preparation of a water-based graphite conductive ink using graphite as conductive material, corn starch powder as binder and distilled water as solvent
- The goal of the proposed work is to develop an affordable, biocompatible, eco-friendly and simple to prepare conductive ink

METHOD

Materials

Laboratory-grade materials were used for the preparation of the ink, listed as:

- Pure powdered graphite (98% pure)
- Distilled water
- Corn starch powder

Synthesization Process

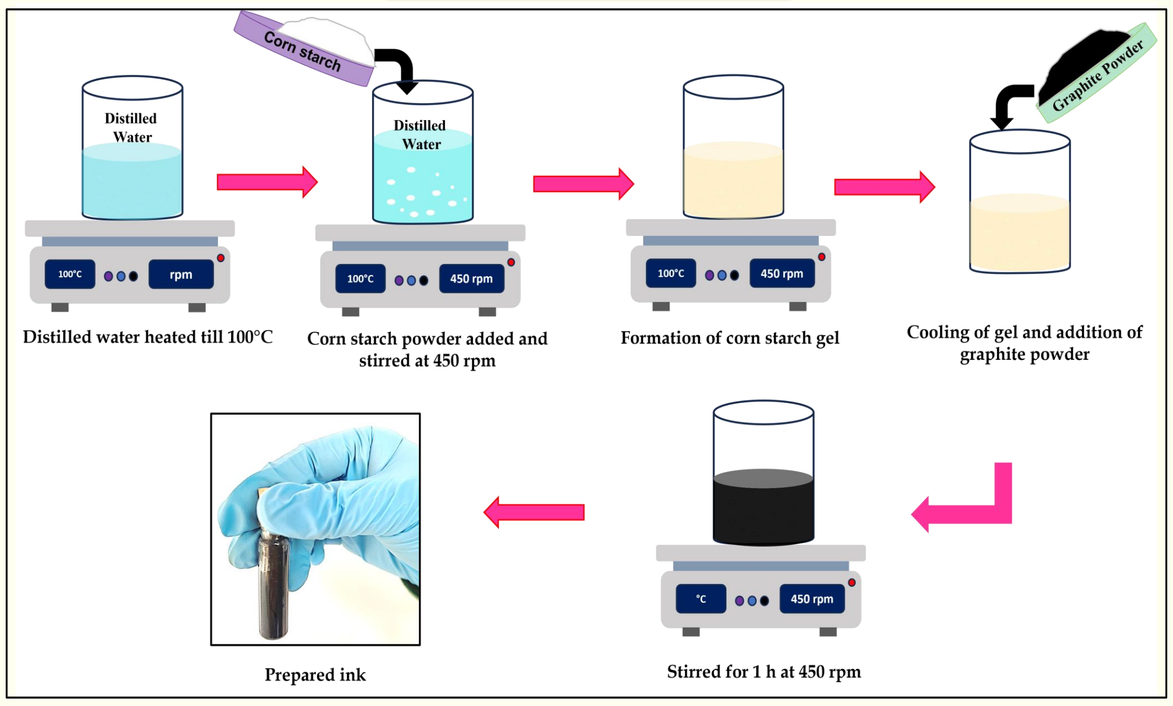

Fig 1. Steps of preparation of the conductive ink

The water-based graphite conductive ink was prepared using the following steps:

1. 20 mL distilled water was heated up to 100 °C.
2. 1 g corn starch powder was added to it and continuously stirred at 450 rpm till a gel-like consistency was achieved.
3. After cooling the solution, 3 g powdered graphite was added to it and stirred at 450 rpm for 1 h.
4. The final product was a black, homogenous and viscous fluid.

The prepared ink was kept in an airtight container for future use and remains stable for up to 7 days without coagulating.

RESULTS & DISCUSSION

Conductivity Test

The conductivity test of the prepared ink involved brush-painting it onto a paper substrate with dimensions of 20 mm × 10 mm. Wires were connected to the substrate using copper tape to form terminals. The ohmic resistance was measured with a digital multimeter and found to be 560 ohm, highlighting the ink's highly conductive nature.

Fig 2. Prepared ink brush-painted on a paper substrate

Characterization

The conductive ink was characterized using different techniques. The X-ray Diffraction (XRD) plot was obtained using the Empyrean Power X-ray Diffractometer (PANalytical). Thermogravimetric analysis (TGA) was conducted using the Thermal Analysis System TGA 2 (Mettler Toledo).

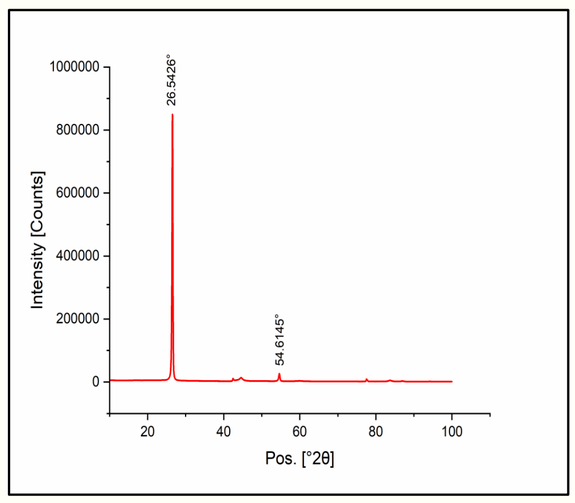

Fig 3. XRD analysis of the conductive ink

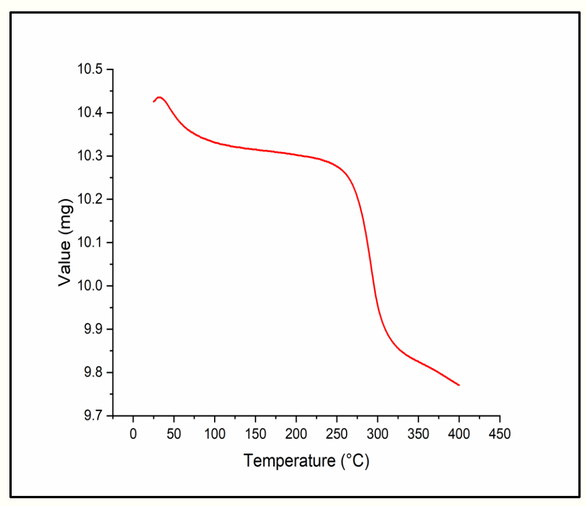

Fig 4. TGA analysis of the conductive ink

The presence of graphite with corn starch was confirmed by a prominent X-ray diffraction (XRD) peak at 2θ = 26.5426°, a minor peak at 2θ = 54.6145°, and several other small peaks.

TGA revealed that the conductive ink exhibits excellent thermal stability up to 275°C, with minimal weight loss. However, significant thermal degradation was observed at 400°C.

CONCLUSION

- ✓ This work reports the development of a conductive ink prepared using graphite, corn starch powder and distilled water for printed electronics
- ✓ The ink was formulated through a straightforward series of steps, making the preparation process simple and efficient
- ✓ The prepared ink showed a low ohmic resistance establishing its highly conductive nature
- ✓ XRD plot confirmed the presence of graphite as the main element of the ink
- ✓ TGA plot showed that the ink exhibits thermal stability up to 275 °C, after which it showed thermal degradation
- ✓ Thus, this conductive ink can offer a simple and low-cost alternative for applications in printed electronics

REFERENCES

[1] Khan, Y., Thielens, A., Muin, S., Ting, J., Baumbauer, C., & Arias, A. C. (2020). A new frontier of printed electronics: flexible hybrid electronics. Advanced Materials, 32(15), 1905279.

[2] Oliveira, A. E. F., & Pereira, A. C. (2021). Development of a simple and cheap conductive graphite ink. Journal of The Elec-trochemical Society, 168(8), 087508. Author 1, A.; Author 2, B. Book Title, 3rd ed.; Publisher: Publisher Location, Country, 2008; pp. 154–196.

[3] Qin, Y., Ouyang, X., Lv, Y., Liu, W., Liu, Q., & Wang, S. (2023). A review of carbon-based conductive inks and their printing technologies for integrated circuits. Coatings, 13(10), 1769.

[4] de Oliveira Cândido, T. C., Pereira, A. C., & da Silva, D. N. (2023). Development and characterization of conductive ink composed of graphite and carbon black for application in printed electrodes. Analytica, 4(4), 513-526.

[5] de Freitas, R. C., Fonseca, W. T., Azzi, D. C., Raymundo-Pereira, P. A., Oliveira Jr, O. N., & Janegitz, B. C. (2023). Flexible electrochemical sensor printed with conductive ink made with craft glue and graphite to detect drug and neurotransmitter. Microchemical Journal, 191, 108823.