

Conductive Nanosilver Ink as RFID-Based Humidity Sensor

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Structured Abstract

Background: The integration of humidity sensing with wireless identification technologies, such as RFID, has gained interest for applications across sectors such as healthcare and food safety. Conductive inks formulated with nanoscale silver particles offer advantages in electrical conductivity and environmental resistance compared to conventional metallic RFID fabrication, potentially enabling flexible, printable, and cost-effective humidity sensors.

Methods: Silver nanoparticles were synthesised via chemical reduction using D(+)-glucose-monohydrate as a reducing agent and polyvinylpyrrolidone (PVP) as a stabiliser in an alkaline medium. The synthesised nanoparticles were formulated into conductive ink using PEG 600 and ethanol as the solvent system, with a nanoparticle content of 40% by weight. The ink was characterised for optical, physical, thermal, electrical, and mechanical properties. UV-Vis spectroscopy confirmed the formation of silver nanoparticles, while viscosity, surface tension, and density measurements assessed the physicochemical suitability for screen printing. Thermal stability was evaluated using thermogravimetric and calorimetric analyses. Electrical conductivity was measured using a four-point probe, and mechanical durability was assessed using pencil hardness testing.

Results: The synthesised nanoparticles exhibited a surface plasmon resonance peak at 434.95 nm, indicating particle sizes of approximately 40–50 nm. The formulated ink exhibited a viscosity of 1417 cP and a surface tension of 40.82 mN/m, both within acceptable ranges for screen printing. Thermal analyses showed solvent evaporation below 220 °C and polymer degradation between 219 and 431 °C, suggesting stability for low-temperature applications. However, printed samples demonstrated low electrical conductivity, ranging from 4.62×10^{-4} to 8.72×10^{-3} S/cm, and poor mechanical durability with pencil hardness below 6B. These limitations are attributed to the absence of sintering, high PEG content, and incomplete film drying.

Conclusion: In conclusion, this study establishes a foundational formulation of conductive nanosilver ink suitable for screen-printing in RFID-based humidity sensors. Despite observed limitations, future improvements such as post-printing sintering, increased silver loading, alternative binders, and mechanical reinforcement are recommended to enhance conductivity and durability for practical sensor integration.

Keywords: Conductive Nanosilver ink, RFID humidity sensor, silver nanoparticles, screen printing, chemical reduction synthesis

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