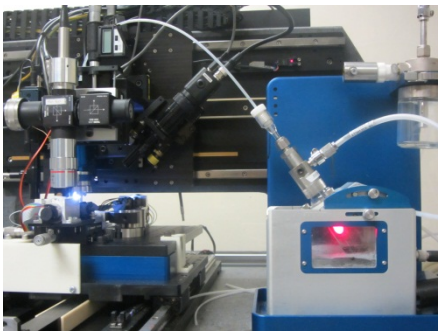
UNIVERSITY OF WATERLOO

TECHNOLOGY SUMMARY



Aerosol-jet printing system used for 3D printing of graphene interconnects

Graphene Printing

Background

Graphene, as a 2-dimensional crystalline allotrope of carbon with exceptional electrical and mechanical properties, has attracted many researchers and industrial sectors to adopt it as a potential alternative to traditional metallic elements for printed electronics, interconnects and semiconductor applications. Flexibility of the 2D or 3D printed graphene interconnects is one of its most important advantages. Graphene, once printed, can be deformed without negatively affecting its performance. So graphene is an ideal candidate for flexible electronic components and development of printing processes of graphene is necessary.

Description of the invention

The present research combines the advantages of graphene and additive manufacturing (AM) by integrating graphene in a micro-scale aerosol-jet AM process. To print graphene patterns, a high-concentration graphene-based ink, compatible with the AM system, was developed using a chemical exfoliation process. This ink, with a graphene concentration of 3.1 mg/mL and a viscosity of 20 cP, comprises graphene flakes with lateral dimensions below 30 nm, ethyl cellulose as a stabilizer for graphene flakes, and a mixture of solvents that are compatible with the printing process. Subsequently, the graphene patterns with resistivity as low as 0.018 Ω.cm and widths ranging from 10 to 90 microns was successfully performed. These patterns, which are the finest ever printed graphene patterns, may develop miniaturized printed electronic applications of graphene.

Advantages

Compared to other ink-based AM processes, aerosol-jet printing system is capable of printing inks with a wide range of viscosity (1 to 1000 cP). So printing inks with higher graphene concentrations, and consequently, higher conductivity for printed interconnects is expected. Small droplet sizes (1 to 5 micron) in aerosol-jet printing also result in micro-scale graphene features as small as 10 microns in width. Different adjustable parameters involved in deposition process results in manageable width for the printed patterns.

Potential applications

Graphene printed patterns as the most flexible conductive printed interconnect can be used in different applications including but not limited to:

- Flexible electronics such as flexible tablets and cellphones.
- Supercapacitors.
- Light emitting diodes (LEDs) in environments such as information displays and biomedical systems.

Reference

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