Foldable Circuits and Organic Electronic Devices based on Solution-processed Graphene Composites and Inkjet Printing

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Abstract

A facile and cost-effective strategy for foldable and flexible electronics is solution process, such as inkjet printing, of graphene-based materials, which will be also useful for application with large area or ultra-thin form factor. In this presentation, graphene ink and graphene/silver nanowire (AgNW) paste were formulated and printed on the surface-treated flexible/foldable substrates, including plastic or functionalized paper. Circuits of the graphene nano-plates, prepared on the paper substrate by simple transfer printing, showed a very small change in the conductance under various folding angles, retaining more than 90% of initial conductance after repeated cycles [1]. Moreover, compared with electrodes formed by neat graphene, graphene/AgNW circuit showed superior performance both for sheet resistivity as well as folding stability. For the inside (−180◦) and outside (+180◦) folding angle condition, the circuits revealed much smaller change in conductance, maintaining the electronic path on foldable paper.

Due to the lack of transparency for most paper-based substrate, top-emitting organic light emitting diode (TOLED) was employed, where its light emitting behavior and efficiency were investigated in terms of the multilayer surface composition on paper and functionality. TOLED on paper was prepared by thermal evaporation or printing of several organic layers onto the reflective anode, where the interconnecting graphene/AgNW circuit supplied the bias voltage and current. Electrical and luminous properties of TOLED were dependent upon the applied bias voltage driven by graphene/AgNW electrodes [2].

Solution-phase direct exfoliation of neat graphene is favorable for maintain higher conductivity of printed patterns [3]. We have dispersed graphene nano-platelets in methanol, with 0.5wt% polymeric surfactant (such as triton X-100). Improved uniformity and printability of graphene-based ink materials and their patterns were evaluated using the commercial inkjet/simple nozzle printing. Tiny droplets of graphene or graphene-AgNW composite solution ink could be jetted onto a fast-moving substrate to produce 100μm-width pristine line patterns. Pattern uniformity and resolution were further controllable by the adjusting of the surface tension via ink formulation as well as modification of functional surface of paper substrates. Organic thin film transistor with various patterns/channel length of graphene-base electrodes were fabricated for the evaluation of printed graphene circuits.

References

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