Graphene-based linear tandem micro-supercapacitors with high-voltage output and unprecedented integration for printed electronics

With the support by the National Natural Science Foundation of China, Prof. Wu Zhongshuai (吴忠帅) and Prof. Bao Xinhe (包信和) *et al*. from Dalian Institute of Chemical Physics, Chinese Academy Sciences developed graphene-based linear tandem micro-supercapacitors with metal-free current collectors and high-voltage output, which was published in *Advanced Materials* (DOI: 10.1002/adma.201703034).

Printable supercapacitors have been considerably regarded as a promising class of compact, lightweight, and reliable energy storage devices, which are desired for direct integration with printed electronics. However, such supercapacitors are still facing huge challenges in high-voltage output and robust flexibility arising from the stacked device geometry, in which the separator and metal interconnects are highly required when multiple cells are connected in series and/or parallel for boosting the voltage output and/or capacitance.

To address this issue, their group developed a scalable printable technique for the facile fabrication of new-type planar linear tandem micro-supercapacitors (LTMSs) with metal-free current collectors and interconnects, high-voltage output, outstanding flexibility and unprecedented integration, based on fully printed graphene-based materials on the various flexible substrates, e. g., A4 paper.

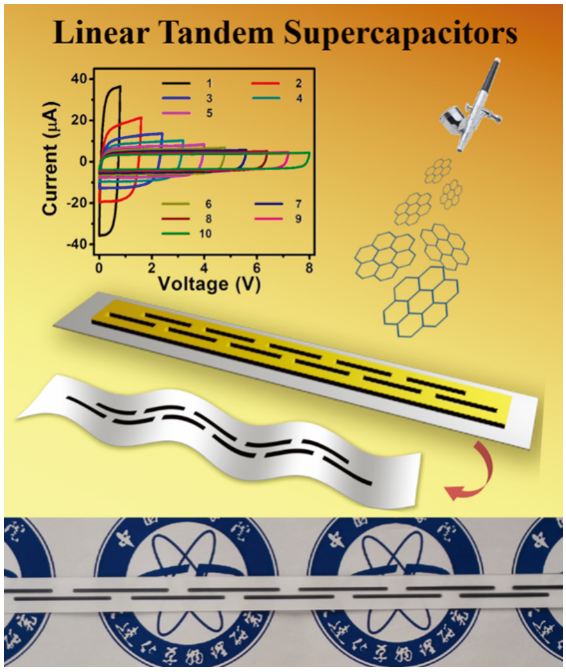

Figure Schematic (up) and optical image (down) of graphene-based LTMSs.

The fabricated graphene-based LTMSs consisting of 10 micro-supercapacitors (MSs, 0.8 V) presented efficient high-voltage output of 8.0 V, and remarkable flexibility without obvious capacitance degradation under different bending states. Moreover, areal capacitance of LTMSs could be sufficiently enhanced by incorporating pseudocapacitive polyaniline into graphene electrodes. Using asymmetric device geometry, the voltage output and energy density of LTMSs were simultaneously improved, through controlled linear patterning of graphene nanosheets as negative electrodes and MnO_2 nanosheets as positive electrodes. Notably, asymmetric LTMSs from three serially-connected MSs were easily extended to 5.4 V, triple voltage output of single cell (1.8 V), demonstrative of versatile applicability of their technique.

This versatile printable strategy will pave a way for the simplified production for planar tandem energy storage devices, and can be directly extended to ink jet printing, 3D printing, screen printing, and roll-to-roll process for mass production of LTMSs. Therefore, their work offers numerous opportunities of graphene and analogous nanosheets for scalable fabrication of printable planar tandem energy storage devices integrating with printed electronics.