Inkjet Printed Large-Area Flexible Few-Layer Graphene for thermal energy detection and harvesting

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In order to effectively use thin films with low thermal mass, one needs to tailor the microscopic atomic structure in an ingenius manner to optimize the interplay between thermal and electrical conductivity. Graphene-based organic nanocomposites have ascended as promising candidates for thermoelectric energy conversion. One major interest for the use of carbon-based materials is to develop inks. To adopt existing scalable printing methods for developing thermostable graphene-based thermoelectric devices, optimization of both the material ink and the thermoelectric properties of the resulting films are required. Here, inkjet-printed large-area flexible graphene thin films with outstanding thermoelectric properties are reported. [1] The thermal and electronic transport properties of the films reveal the so-called phonon-glass electron-crystal character. As a result, the all-graphene films show a room-temperature thermoelectric power factor of 18.7 $\mu Wm^{-1}K^{-2}$, representing over a threefold improvement to previous solution-processed all-graphene structures. The demonstration of inkjet-printed thermoelectric devices underscores the potential for future flexible, scalable, and low-cost thermoelectric applications, such as harvesting thermal energy or 2D mapping of heat sources that are in contact with the thin film.

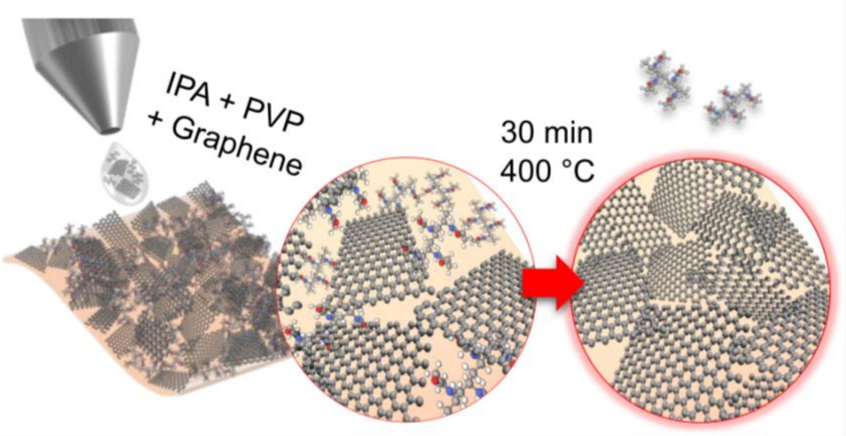

Fig. 1. Deposition and annealing scheme of the exfoliated few-layer graphene flakes suspended in an IPA/PVP solution.

[1] Taneli Juntunen, Henri Jussila, Mikko Ruoho, Shouhu Liu, Guohua Hu, Tom Albrow-Owen, Leonard W. T. Ng, Richard C. T. Howe, Tawfique Hasan, Zhipei Sun, and Ilkka Tittonen, Advanced Functional Materials, **28**, 1800480 (2018).