Graphene nanomechanical piezoresistive sensor

Shou-En Zhu,[1] Victor E. Calado,[2] Chao Zhang,[2] G.C.A.M. Janssen[1]
[1]Precision and Microsystems Engineering, Delft University of Technology, Delft, The Netherlands
[2]Kavli Institute of Nanoscience, Delft University of Technology, Delft, The Netherlands
shouen.zhu@tudelft.nl

Graphene offers a wealth of possibilities for micro- and nano-mechanical applications. Our work on the piezoresistive effect of graphene synthesized by chemical vapor deposition and the graphene polymeric hybrid cantilever has already demonstrated a promising application [1]. The cantilever deflection was monitored by measuring the electrical resistance change of graphene with the mechanical stress. This method has a very high sensitivity and a high efficiency to miniaturize. However, the absence of a robust integration method for graphene films and the lack of a detailed understanding of the electro-mechanical behavior constitute the main obstacles for using this material. Here, we propose a scalable integration method by patterning graphene serpentine resistor onto more robust silicon nitride film (100 nm thickness) and cutting the cantilever shape (100-200 μm length) by focused ion beam milling. We will demonstrate the robustness of the fabriaction method by measuring the extremely high Young's modulus, the piezoresistive effect, the negative thermal expansion coefficient, and the strong substrate adhesion force of graphene. By varying an applied vertical force or input current, we expect deflection and temperature dependent resistance of graphene to change, which can be utilized for ultra-sensitive metrological applications.

References

[1] Shou-En Zhu et al. Graphene based bimorph microactuators, Nano Lett. **11** (2011) 977-981.

Figures

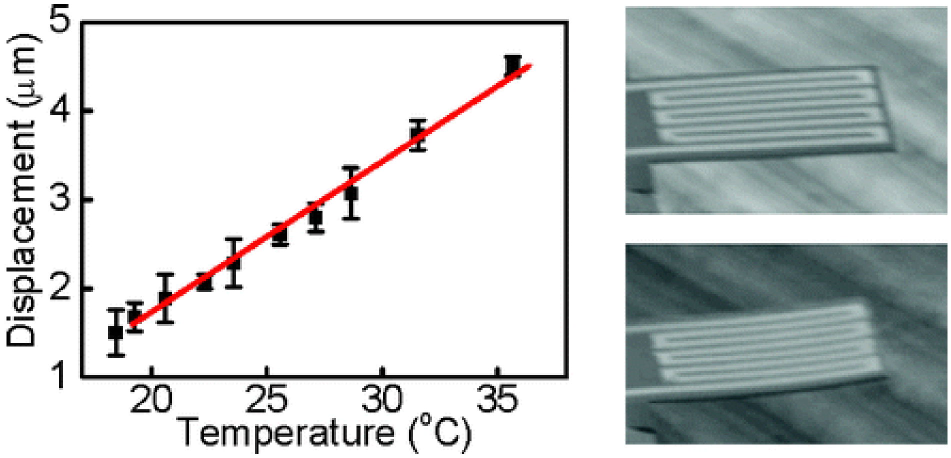

Fig. 1 Tip displacement of the polymeric hybrid cantilever beam as a function of temperature. Each data point is the average value of five measurements, and the standard deviation is shown as error bars. The solid line shows the fit to the data obtained from finite element analysis. The top right figure shows the SEM images of the initial position of the cantilever beam, and bend up state upon applying electrical power (right bottom).

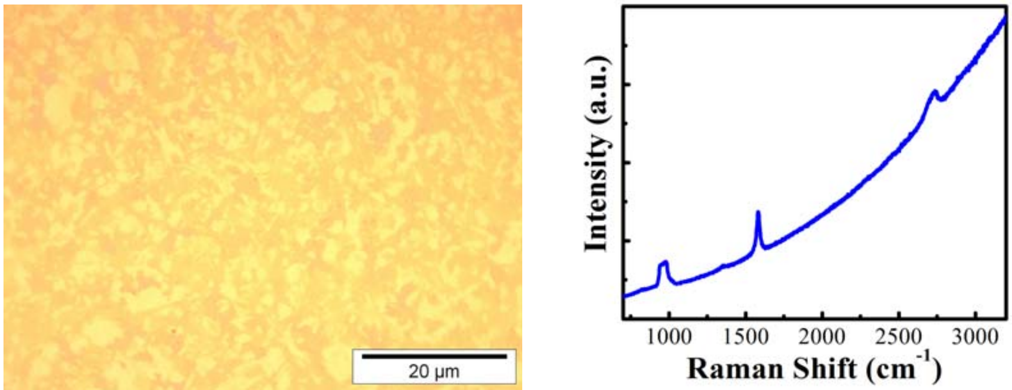

Fig. 2 Optical image and raman spectra of the large-area graphene layers transferred on silicon nitride membrane.