Graphene-polymer heterostructure membranes for micro-electromechanical systems

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Piezoresistive quality graphene is used in a wide variety of graphene pressure sensing studies. In 2013 a study was completed that proved monolayer CVD graphene suspended over rectangular cavities, surpassed conventional pressure sensors areal sensitivity. However, it was unable to operate in air and required an argon environment. In 2017 another study was completed which utilized piezoresistive quality graphene in place of capacitive. This yielded a high sensitivity, and a pressure range from 0 to 80kPa. The main limitation of this device was its temperature dependence, higher temperatures caused an increase in pressure which led to joule heating.

For this work, graphene polymer heterostructure (GPH) membranes are investigated for use in MEMS. The Föppl-Von-Kármán (FvK) equations were used to model GPH membranes on a capacitive pressure sensor seen in figure 1. This was successful in providing a deformation profile over the entire range of membrane deflection. Afterward, the device was fabricated and tested using the micro blister inflation method. The results were compared to the simulation. It is concluded that the FvK equations are more accurate than their predecessors, the non-linear pure-stretching model and the linear pure-bending model. The method can be applied to GPH NEMS technology such as microphones and pressure transducers.

References

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Figures

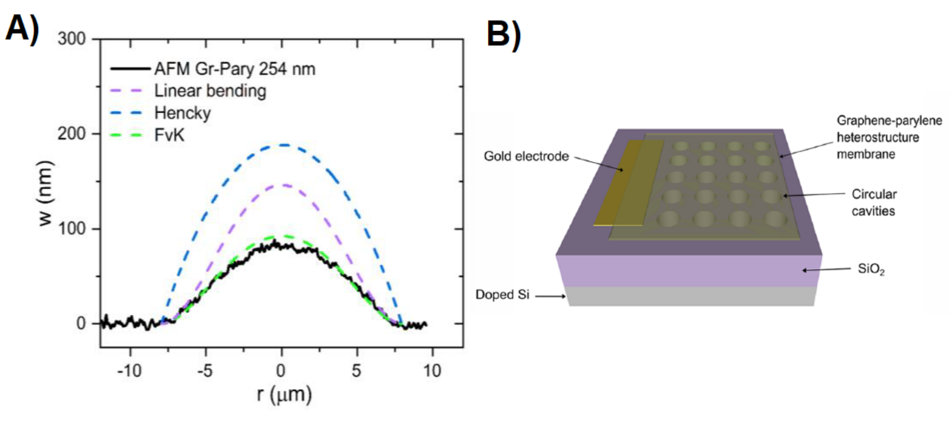

Figure 1: A) GPH membrane deflection against radial position compared to linear bending, Hencky's solution and FvK models. B) A schematic showing the 3D graphene MEMS device model.