Ultra-large suspended graphene for pressure sensors

Shih-Ming, He
Yu-Min Chen and Ching-Yuan Su

Graduate Institute of Energy Engineering, National Central University, No. 300, Zhongda Rd., Zhongli District, Taoyuan City 32001, Taiwan

jackey10102001@hotmail.com

Abstract

In this work, we fabricate ultra-large suspended graphene membranes, where stacks of a few layers of graphene could be suspended over a circular hole with a diameter of up to 1.5 mm, with a diameter to thickness aspect ratio of 3×10^5, which is the record for free-standing graphene membranes. The process is based on a gradual solvent replacement technique with thermal annealing to reduce polymer residue results in an extremely clean surface, where the ultra-large suspended graphene retains the intrinsic features of graphene, including phonon response and an enhanced carrier mobility (200% higher than that of graphene on a substrate). The highly elastic mechanical properties of the graphene membrane are demonstrated, and the Q-factor under 2 MHz stimulation is measured to be 200–300. A graphene-based capacitive pressure sensor is fabricated, where it shows a linear response and a high sensitivity of 15.15 aF Pa^{-1}, which is 770% higher than that of frequently used silicon-based membranes.

References

[1] Yu-Min Chen et al., Nanoscale, 8, 3555 (2016)
[2] S. Saleh et al., IECON 2006 – 32nd Annual Conference on IEEE Industrial Electronics, 6–10 Nov. 2006, pp. 3166–3169
[3] Y. H. Wu and C. H. Chien, Tatung University, 2008.

Figures

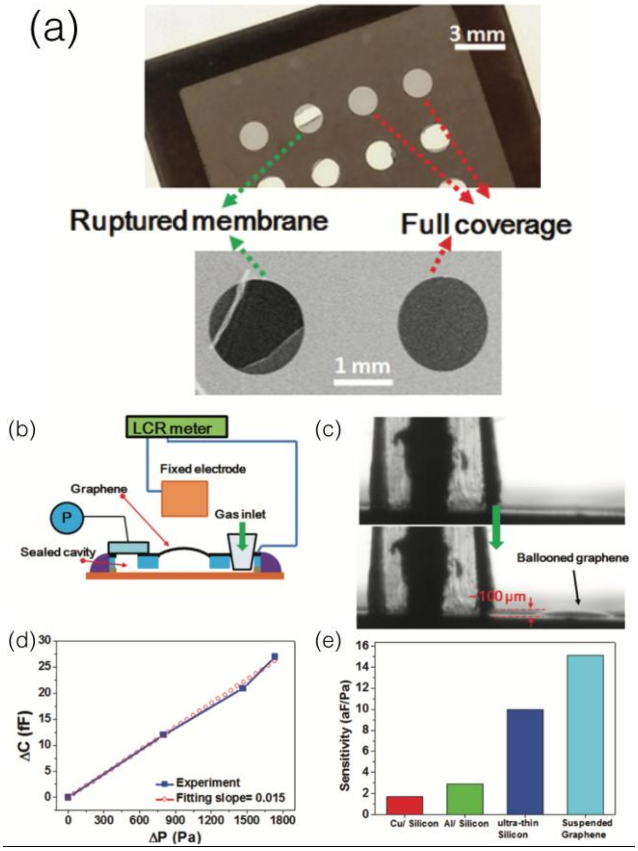

Figure 1: (a)The optical and SEM images for the ruptured and full coverage graphene membranes on the substrate with 1.5 mm diameter holes. (b) Schematic illustration of the sensor design and setup. A LCR meter was used for real-time recording of the capacitance variation. (c) Optical images of the ballooned graphene membrane when the gas flows into the chamber, where the suspended diameter is 1.5 mm and the estimated deformation is ~100 μm. (d) The correlation of capacitance change and measured pressure variations; the sensitivity is defined as $\Delta C/\Delta P$. (e) Histogram of the sensitivity for this work compared to other conventional capacitive pressure sensors made using Cu/Si, Al/Si, and ultra-thin Si membranes [2][3] with MEMS technologies.