Graphene Integrated MEMS Devices for Exploring Strain-induced Novel Physics of 2D Materials

Mounika Vutukuru,
Jason W. Christopher,
Zhuofa Chen,
David J. Bishop,
Anna K. Swan

Boston University Dept. of Electrical and Computer Engineering, 8 St Marys St, Boston, MA, 02215, USA.

mounikav@bu.edu

2D materials are unique in that many of their material properties, such as doping and band-gap, are dynamically tunable. Strain engineering is provides a promising way to access and tune their electronic properties. We integrate 2D materials with MEMS technology which offers tremendous control over the strain field and is readily compatible with modern electronics. We have previously achieved success in straining MoS2 in to 1.3% using MEMS [1]. Here we report on the use of thermally-isolated electrothermal MEMS actuators [2] to uniaxially strain monolayer graphene, as confirmed through micro-Raman spectroscopy. This was achieved through the development of gold micro-riveting to anchor the 2D material in place. We also examine two-terminal electrical transport through MEMS-strained graphene. The application of controlled strain using MEMS therefore allows for the investigation of electrical and mechanical interplay in strained 2D materials, opening the door to the development of strain-based 2D electronics.

References

[1] J. W. Christopher et. al., "Monolayer MoS_2 Strained to 1.3% With a Microelectromechanical System," *JMEMS*, doi: 10.1109/JMEMS.2018.2877983 (2019) pp 1-10

[2] M. Vutukuru et. al., 'Modeling and Thermal Metrology of Thermally Isolated MEMS Electrothermal Actuators for Strain Engineering of 2D Materials," arXiv:1811.05450 [physics.app-ph]

Figures

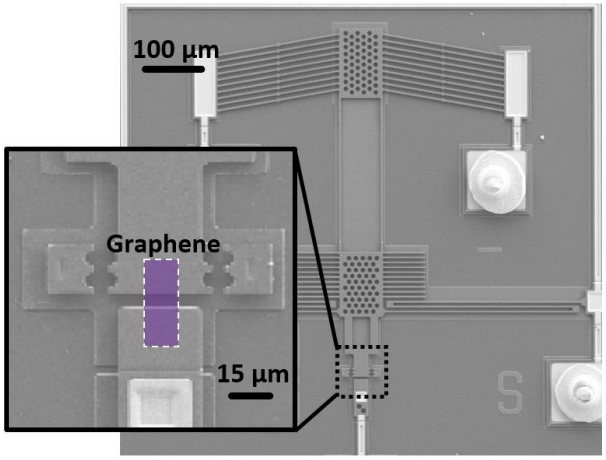

Figure 1: SEM image of the thermally-isolated MEMS actuator with a fictitious graphene film suspended in purple spanning the gap between the anchored and movable stages.

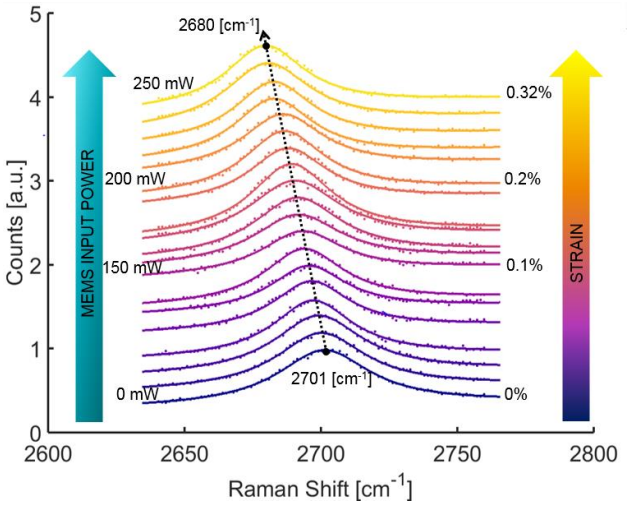

Figure 2: Raman spectra showing 2D peak of suspended graphene shifting with increasing power to the MEMS device, indicating strain in the suspended graphene.