Flexible Resistive Strain Sensors for Application in Wearable Electronics

Zeeshan Alam Ansari[1, a)], Suraj Baloda[2], Sadanand Powar[3], Sk Masiul Islam[4, 5, b)] and Sumitra Singh[1, 5]

[1]*Flexible and Non-Silicon Electronics, Council of Scientific and Industrial Research-Central Electronics Engineering Research Institute (CSIR-CEERI), Pilani, Rajasthan 333031, India*
[2]*Dept. of Electrical and Electronics Engineering, Birla Institute of Technology and Science, Pilani, Rajasthan 333031, India*
[3]*Department of Physics, National Institute of Technology, Warangal, Telangana, India*
[4]*Optoelectronics and MOEMS, Council of Scientific and Industrial Research-Central Electronics Engineering Research Institute (CSIR-CEERI), Pilani, Rajasthan 333 031, India*
[5]*Academy of Scientific and Innovative Research (AcSIR), CSIR-CEERI Campus, Pilani, Rajasthan 333031, India*

[a)]Corresponding author: zeeshan.alam167@gmail.com,
[b)]sk_masiul@ceeri.res.in

Abstract. We report flexible piezoresistive strain sensors containing two different layers of materials, viz. graphene and graphite, fabricated using a simple solution processing method on flexible polydimethylsiloxane (PDMS) substrates. In-house synthesized graphene and graphite-PDMS nanocomposites are used as active layers into the devices. The microstructure of graphene and graphite-PDMS composites are observed from the scanning electron microscope (SEM) images. Small flakes having a thickness of 10-30 nm are clearly seen from the SEM images. Raman spectroscopy is undertaken to study the fundamental physical properties of graphene and graphite-PDMS nanocomposite. The D, G and 2D bands in the spectra of graphene are located at 1340, 1577 and 2690 cm^{-1}, respectively. The G peak, characteristic main peak of graphene, is raised due to the in-plane vibration of sp^2 hybridized carbon atoms. The 2D peak, two-phonon Raman peak determines the stacks of carbon atoms present in graphene samples. The D peak is attributed to the existence of defects in graphene. The electrical characteristics have been studied in PDMS based flexible devices having two different kind of structures such as Ag/graphene/PDMS and Ag/graphite-PDMS. The gauge factor and sensitivity for the devices containing graphene are determined to be 6.260 and 2.155, whereas those values are found to be 0.906 and 0.051 for graphite-PDMS nanocomposite-based devices, respectively. Graphene based flexible devices are observed to be superior than its graphite-PDMS nanocomposite counterparts. Thus, simple structure, ease of device processing, affordable, portable and accessible along with reasonably good sensitivity; it has great potential for the manufacturing of wearable sensors.

Keywords: Flexible, piezoresistive, strain, graphene, wearable sensors.

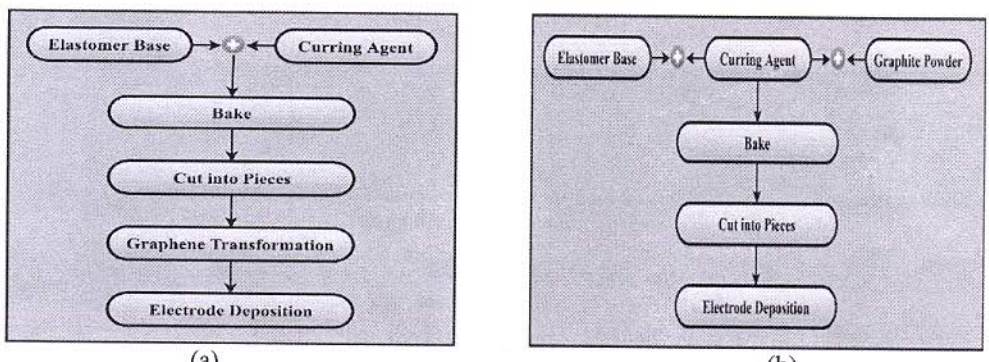
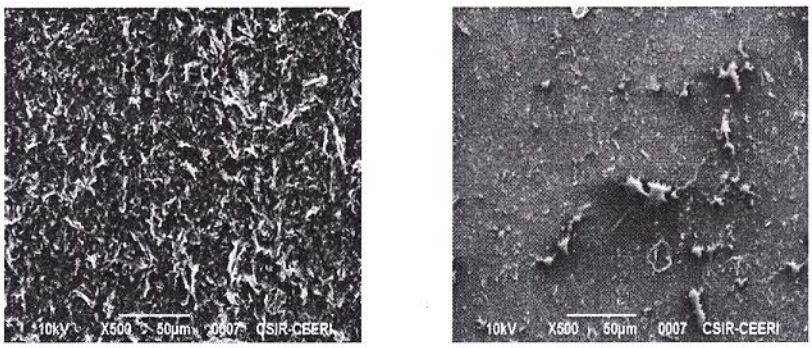


FIGURE 1. Flow chart for the fabrication of (a) graphene and (b) graphite-PDMS based flexible devices.



(a) (b)

FIGURE 2. Scanning electron microscopy images of (a) graphene and (b) graphite-PDMS nanocomposites.

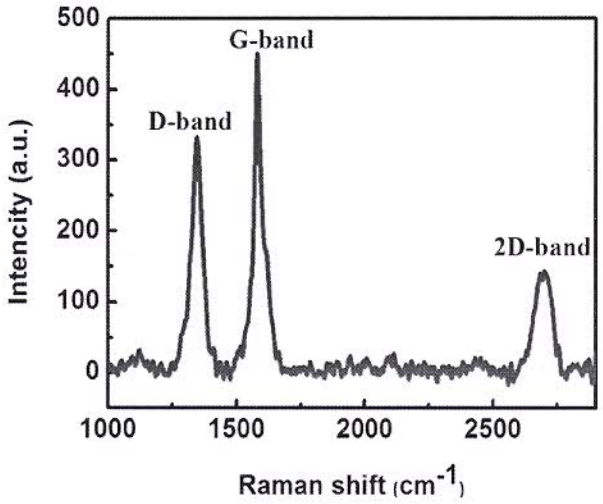
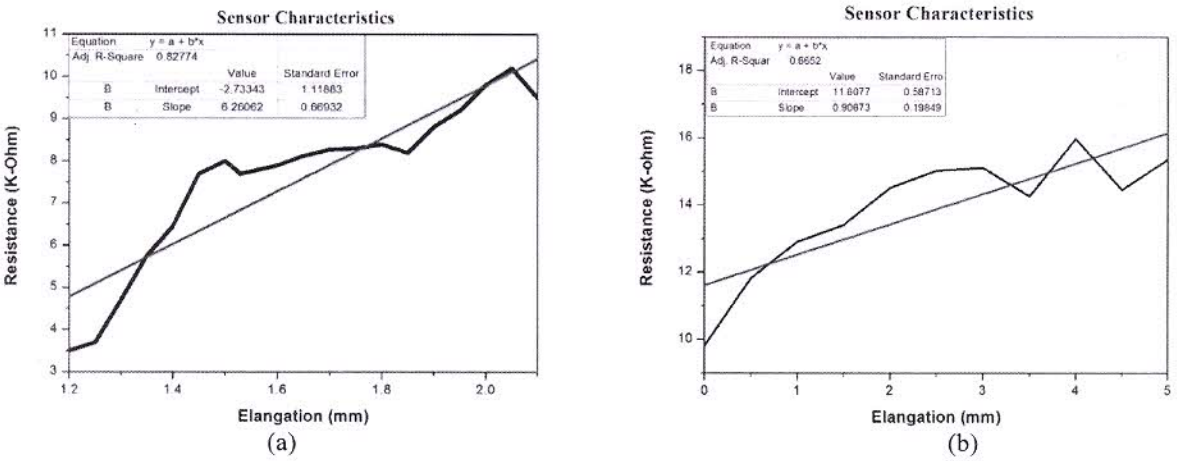


FIGURE 3. Raman spectra of spin coated graphene on flexible PDMS substrate.



(a) (b)

FIGURE 4. Variation in electrical resistance with multiple elongation cycles for the flexible sensors based on (a) graphene and (b) graphite-PDMS composites.