# Sensitive Strain Sensor Based Chemically Reduced Graphene Oxide and Multi Walled Carbon Nanotubes Hybrid Materials

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The fast development of flexible electronic in the last decade emphasizes their attractive perspective in numerous applications where flexibility, miniaturization, and functionality are highly recommended. Whereas the essential components in such multifunctional devices are sensors, this requires it to be flexible and robust for integration. This will point on the need of new smart hybrid materials, to ensure these properties. Due to its promising properties i.e. electrical and mechanical, carbon nanotubes (CNTs) are good candidate for the manufacture of strain sensors to improve its performance. But since the pristine CNTs are chemically inactive, surface activation is an essential precondition. Hybrid nanomaterial graphene oxide: multi-walled carbon nanotube (GO:MWCNTs) was synthesize based on the self-assembly of MWCNTs and GO. Compared with pristine MWCNTs, such a nanocomposite could be well dispersed in aqueous solution via the π–π interaction, this will not only allow stabilize the hydrophobic nanotubes, but also provided the MWNTs with a negative charge.

Previously, a number of techniques were used to create thin piezoresistive layers on flexible substrate used as graphene-based strain sensor. Bae et. al. used a reactive ion etching and stamping techniques to fabricate strain sensor in a form of rosette on a flexible plastic substrate [1]. In [2] a layer of graphene platelets was achieved by filtration followed by transfer of the resulting layer onto a polymer substrate. Hou et al. used a vacuum filtration of a dispersion of CNT + graphene to form a conductive layer which was afterwards transferred onto a polymethylmethacrylate (PMMA) substrate to form the strain sensor [3].

In this research, we presented a chemically reduced GO (rGO):MWCNT nanocomposites which have high piezoresistivity effects for strain sensors. The conductive thin layer was fabricated and deposited using spin coating on flexible substrate (Kapton HN) to fabricate the strain sensor. After the deposition, the films were chemically reduced to enhance the electrical transport of the composite.

The prepared GO:MWCNT films have been characterized using SEM. Results indicate that the MWCNTs were homogeneously dispersed in the GO suspension matrix, as it is shown in Fig. 1.

Their piezoresistive properties were investigated under a universal mechanical load test machine, a tensile strain up to 1.7% was used. The strain response of rGO:MWCNT composites showed linearly symmetrical, excellent repeatability, small hysteresis and its strain sensitivity is higher than the MWNT thin films and comparable to the traditional strain sensor. The rGO:MWCNT (5:0.01wt%) nanocomposites show a remarkable positive piezoresistivity of high sensitivity as it is shown in Fig. 2. These results open a new innovative road toward the fabrication of piezoresistive sensors onto flexible substrates with high performance and high linearity.

## References

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**Figures**

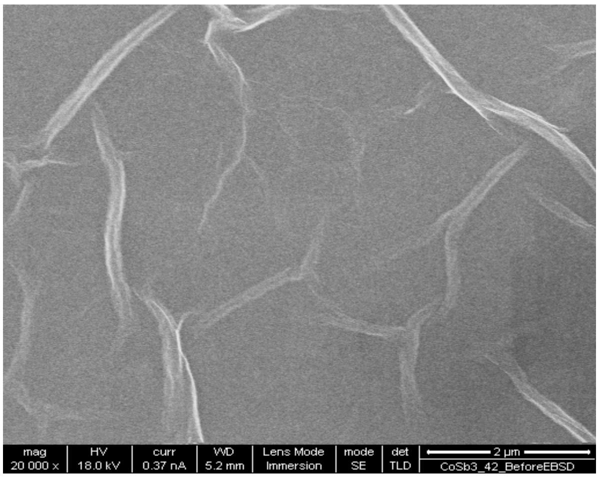


**Fig. 1. SEM image of rGO:MWCNT (0.01: 5 wt%) nanocomposite on deposited on Si-wafer**

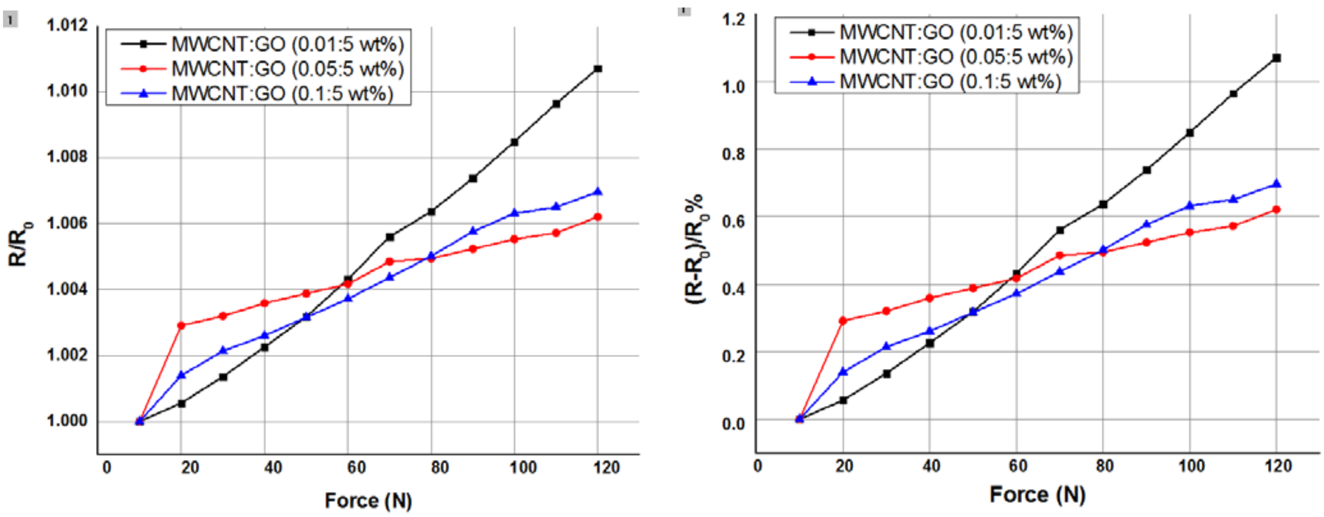


**Fig. 2. (a) The variation of normalized resistance ($R/R_0$) (b) The relative change in the resistance of the rGO:MWCNT nanocomposites with content (0.01, 0.05 and 0.1 wt%) of MWCNT and 5 wt% of GO during uniaxial stressing**