Electronic Supplementary Material (ESI) for RSC Advances.


# Flexible cellulose acetate/graphene blueprints for vibrotactile actuator

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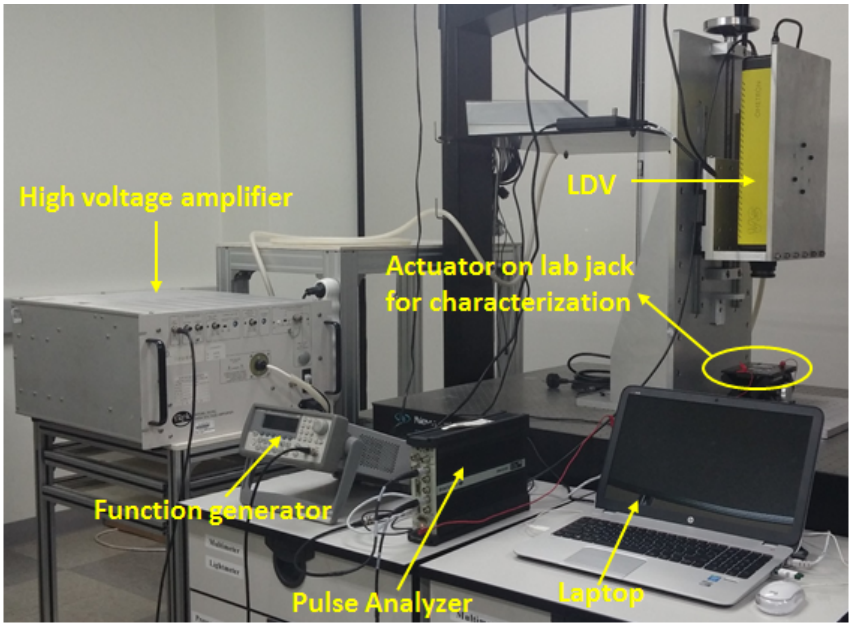


**Figure S1.** Experimental set up of the actuation test

Actuation was observed with the help of a locally fabricated and humidity controlled environmental chamber (Kwang-Myung Science, Korea) containing a movable heating element at temperatures 25 to 40, 60, 80 °C at 25 % relative humidity ($R_H$). The experimental set up is shown in Figure S1 in which the components are marked in detail. Capacitance of the samples placed within was noted and plotted to derive the effect of sensing. A good variation in the actuation behavior was noticed with respect to temperature.

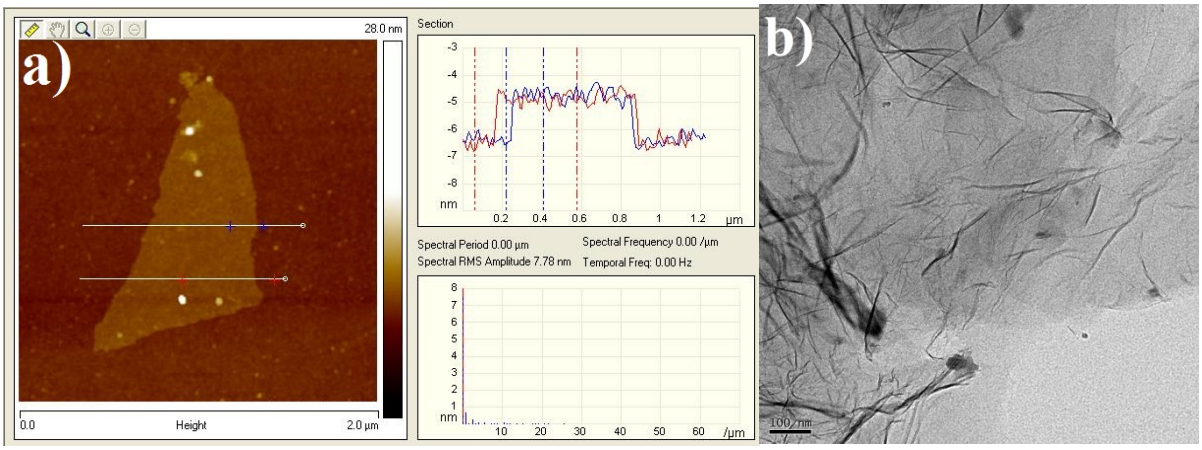


**Figure S2.** a) Two dimensional AFM image of GO casted on silica wafer b) TEM image of GO

The GO synthesized by improved graphene oxide synthesis method was the substrate to obtain reduced graphene oxide (RGO). The morphology of GOs was checked with the help of an atomic force microscope (Veeco AFM) and a high resolution field emission transmission electron microscope (FE-TEM, JEOL, JEM 2100F). The AFM image of the GO sheets casted on silica wafer is given in Figure S2a, from which the thickness of the GO layer was calculated to be ~1.5 nm. For TEM, drops of GO suspension in water (0.01%w/v), were deposited on carbon-coated electron microscope grids and the image as shown in Figure S2b was obtained. The bright-field smooth TEM image reveals the overlapping and barely distinguishable morphology of GOs and its crystallinity.

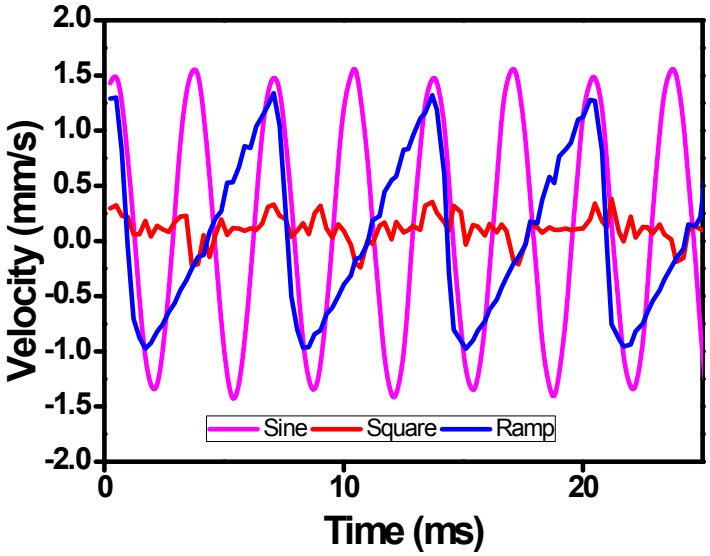


**Figure S3.** CA/m-RGO vibrotactile performance at different wave functions (sine, ramp and square)

The cellulose acetate/modified RGO (CA/m-RGO) composite exhibited excellent actuation and prior to this performance analysis its vibrotactile behavior at different wave functions was checked and the results obtained are given in Figure S3. The sine, square and ramp functions show good variation in their velocity against time.

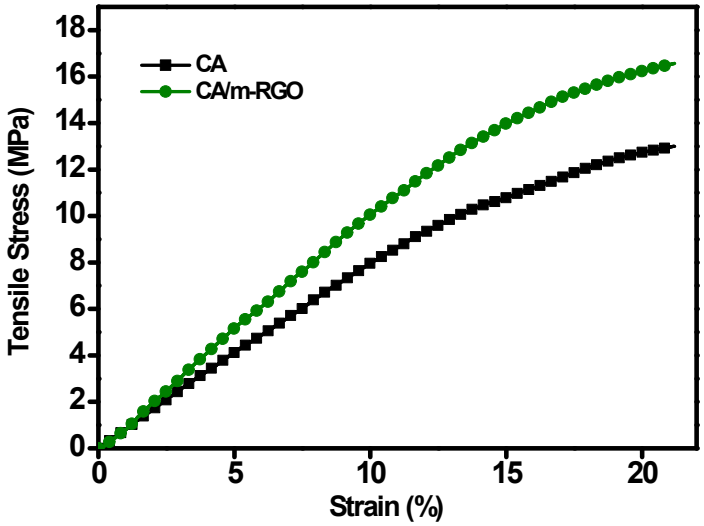


**Figure S4.** Representative stress-strain behavior for CA and CA/m-RGO composite film.

The stress-strain behaviors of the films were measured according to ASTM D-882-97 using a universal testing machine. Test was performed under room temperature and at tension rate of 0.005mm/s. From Figure S4, mechanical properties of CA film increased with the presence of m-RGO. The Young's modulus, calculated from the slope of a linear region of the stress-strain curve, increased by around 32% from 0.67 GPa to 0.89 GPa for pristine CA and CA/m-RGO composite films, respectively.