Electronic Supplementary Material (ESI) for RSC Advances.

Mechanical and electrical properties of multiwall carbon nanotube/polycarbonate composites for electrostatic discharge and electromagnetic interference shielding applications

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Electronic Supplementary Information

SP1. ESD Studies

John Chubb Instrument (JCI 155 v5) charge decay test unit was used for ESD studies for the measurement of static decay time of f-MWCNT/PC samples at room temperature. John JCI 155 v5 charge decay test unit is a compact instrument for easy and direct measurement of the ability of materials to dissipate static electricity and to assess whether significant voltage will arise from practical amount of charge transferred to surface. The static decay time was measured by applying a positive as well as negative high corona voltage of 5000 V on the surface of material to be tested and recording the decay time at 10% cut-off. A fast response electrostatic field meter observes the voltage received on the surface of sample and measurements were to observe how quickly the voltage falls as the charge is dissipated from the film. The basic arrangement for measuring the corona charge transferred to the test sample during corona charge decay measurements is shown in the Fig. S1 (Ref. 27)

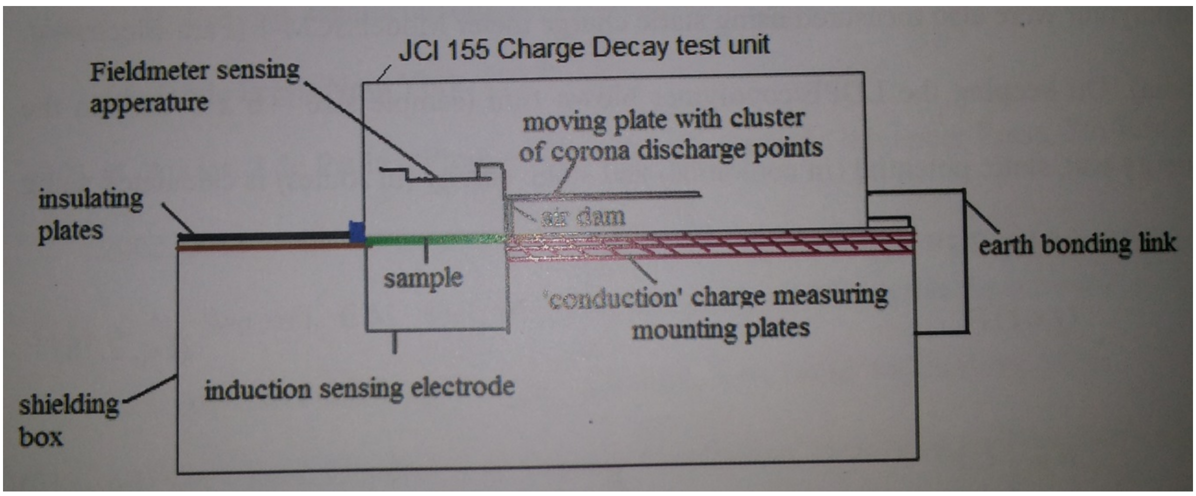

Fig S1 Schematic arrangement of JCI 155 v5

SP2. Tensile stress-strain curve of 0.6 wt% f-MWCNT/PC composite

The tensile stress-strain curve of 0.6 wt% f-MWCNT/PC composite film is shown in Fig. S2. As evident from the figure there is yielding and plastic deformation resulting in a ductile failure (with necking and cold drawing) and rapid increase in stress at which failure occurred.

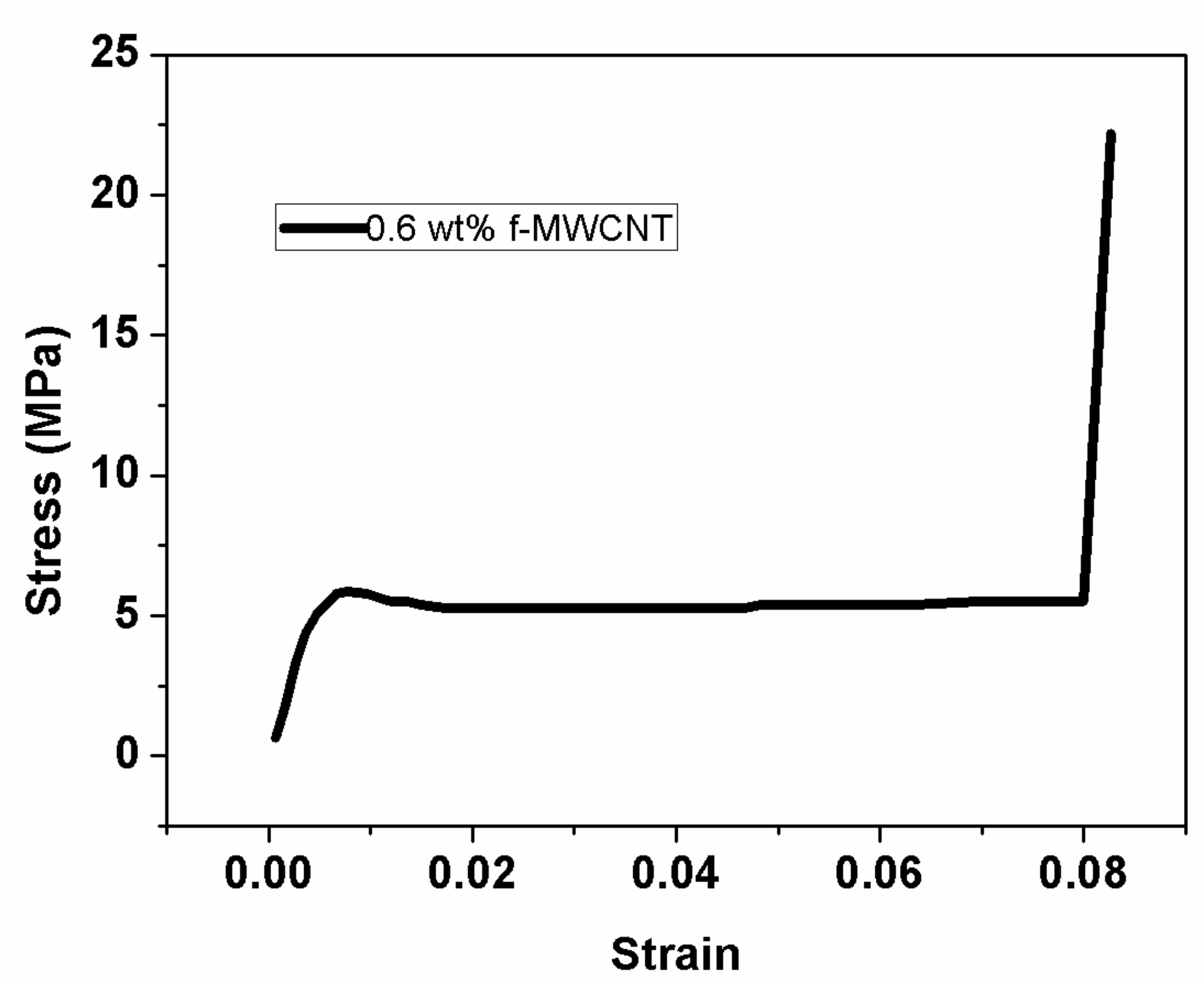

Fig. S2 Tensile stress-strain curve of 0.6 wt% f-MWCNT/PC composite film

SP3. EMI SE

SE measurements were carried out in the 8.2-12.4 GHz microwave range and keeping the input power level at -5dBm (Ref. 38). The total EMI SE is the attenuation of ratio of electromagnetic waves produced inside the shield material and can be expressed as

$$SE_T(dB) = 10\log\frac{p_I}{p_T} = 20\log\left|\frac{E_I}{E_T}\right| = 20\log\left|\frac{H_I}{H_T}\right| \qquad (1)$$

where p_I (E_I or H_I) and p_T (E_T or H_T) are the incident and transmitted electromagnetic powers (electric or magnetic field) respectively. The total shielding can be expressed as sum of three terms:

$$SE_T = SE_R + SE_A + SE_M \quad (2)$$

Where, SE_R, SE_A and SE_M are shielding due to reflection, absorption and multiple reflections respectively. In two port network analysis, the scattering (*S)* parameter i.e. S_{11} (or S_{22}), S_{21} (or S_{12}) can be correlated to reflection and the transmission coefficients as:

$$T = \left|\frac{E_T}{E_I}\right|^2 = |S_{12}|^2 \; (= S_{12}^2) \quad (3)$$

$$R = \left|\frac{E_R}{E_I}\right|^2 = |S_{11}|^2 \; (= S_{22}^2) \quad (4)$$

The absorbance can then be calculated as

$$A = 1 - R - T \quad (5)$$

Here, the term A is given with respect to the power of the incident electromagnetic (EM) wave. If the effect of multiple reflection between both interfaces of the material is negligible, i.e. SE_M=0, the SE_T can be expressed as

$$SE_T = SE_R + SE_A \quad (6)$$

The relative intensity of the effectively incident EM wave inside the materials after reflection is based on the quantity as 1-*R*. Therefore, the effective absorbance (A_{eff}) can be described as

$$A_{eff} = \frac{(1 - R - T)}{(1 - R)} \quad (7)$$

with respect to the power of the effectively incident EM wave inside the shielding material. So SE_R and SE_A are given as

$$SE_R = 10\log(1 - R) \text{ and} \quad (8)$$

$$SE_A = 10\log(1 - A_{eff}) = 10\log\left[\frac{T}{(1 - R)}\right] \quad (9)$$

SP4. Flexural Stress-strain curve of 20 wt% a-MWCNT/PC composite processed by contact pressure (CP) compression molding method

The flexural stress-strain curve of 20 wt% a-MWCNT/PC composite processed by contact pressure (CP) compression molding method is shown in Fig. S3. The average flexural modulus and flexural strength of the composite was 1837 MPa and 45 Mpa respectively.

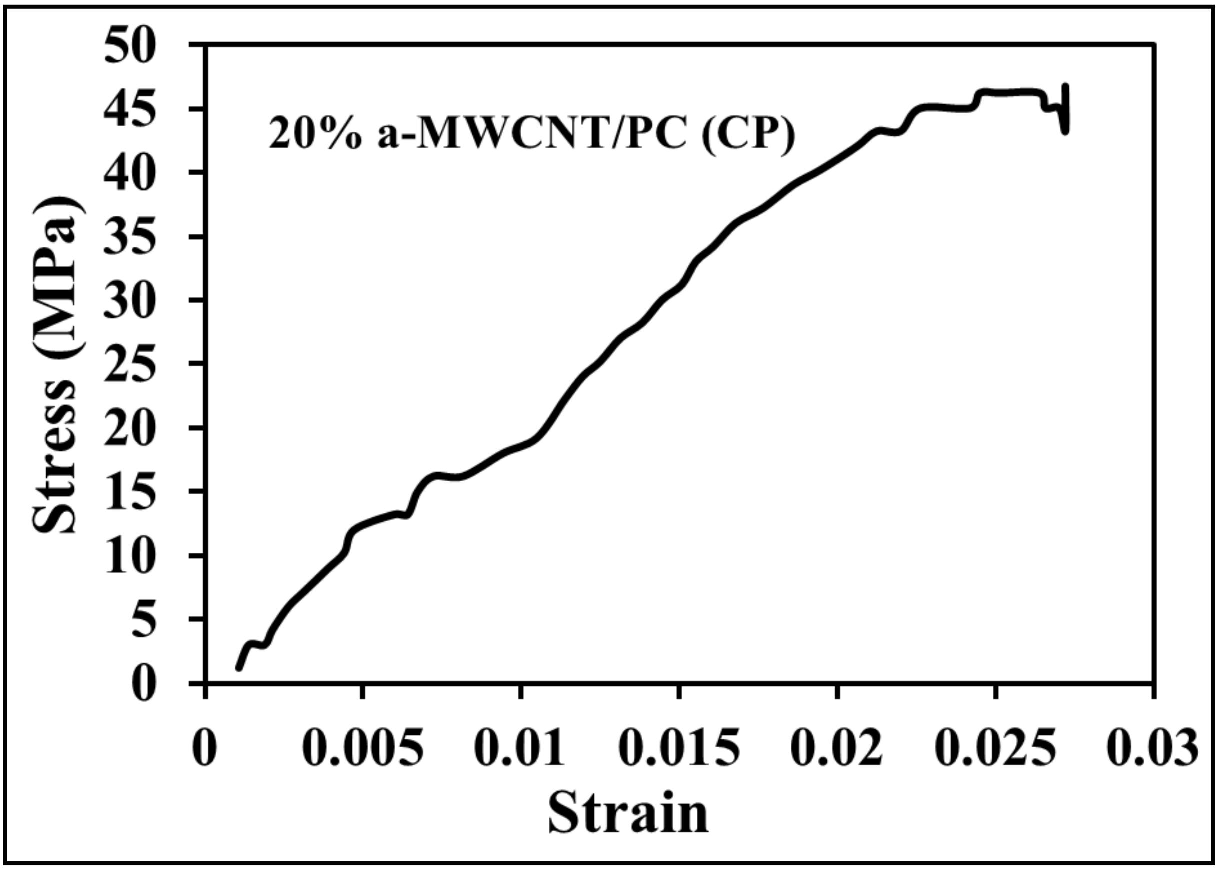

Fig S3. Flexural Stress-Strain curve of 20 wt% a-MWCNT/PC composite processed by contact pressure (CP) compression molding method