Lightweight and solution processable thin sheets of poly (o-toluidine)-carbon fiber-novolac composite for EMI shielding

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Supporting Material Data

1. Vacuum filtration setup for solution casting of PoTCF sheets

Fig. S1 shows the vacuum filteration setup for solution casting of PoTCF sheets before pressing these sheets in compression moulding.
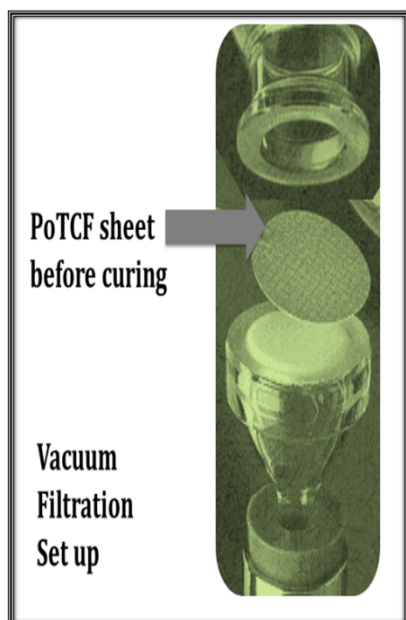

Fig. S1 Vacuum filtration setup

2. UV-Vis spectra

Fig. S2 shows the UV-vis absorption spectra of PoT, PoTCF and PoTCF25 samples. The absorption spectra of PoT prepared in NSA represents same characteristic peaks as that of previous reports. The slight difference in position of peaks may be due to the change in solvent and method of polymerization. The peak at 294 nm can be ascribed to π-π* transition of the benzenoid rings. The peaks at 420 and 824nm can be attributed to polaron-π* transition and π-polaron transition respectively. The peak at 420 nm represents half oxidized emeraldine form of PoT, whereas the peak at 824 nm represents the fully oxidized emeraldine salt. Apart from these characteristic peaks a hump appears at 620 nm, represents the insulating pernigraniline phase of the polymer. The different peaks explain the formation of

different conducting & insulating phases of polymer. On comparing UV-Vis spectra of PoT with PoTCF and PoTCF25 samples, it is observed that PoTCF and PoTCF25 shows same absorption peaks except a slight red shift in first (300nm) and third peak (836nm).
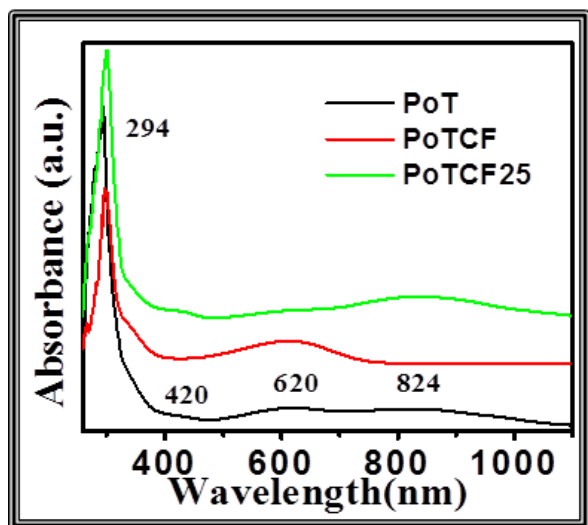

Fig. S2 UV-vis spectra of PoT, PoTCF & PoTCF25 composites

3. Electrical conductivity

The conductivity of PoTCF composite powder samples having different amount of novolac resin, measured by the same four probe conductivity measurement technique, is found to be less than their respective sheet samples (Table S1).

Table S1 Electrical conductivity of the PoT & PoTCF composite powders

Sample	Phenolic Resin (wt. %)	CF (wt. %)	Conductivity (S/cm)
PoT	0	0	2.62×10^{-3}
PoTCF	0	20	5.4×10^{-1}
PoTCF25 powder	25	20	1.0×10^{-1}
PoTCF50 powder	50	20	4.1×10^{-2}
PoTCF75 powder	75	20	1.6×10^{-5}

4. Penetration Depth

For a shield, the penetration depth or skin depth (δ) is the distance up to which the intensity of the EM wave decreases to 1/e of its original strength. Therefore thickness of the shield should be equal or greater than the penetration depth. The expression for δ could be deduced from SE_A as:-

$$SE_A(dB) = 20 \left\{ \frac{t}{\delta} \right\} \log e = 8.68 \left(\frac{t}{\delta} \right)$$

where, t is the thickness of the shield ; and δ is skin depth.

The skin depth δ can be expressed as:

$$\delta = 8.68\frac{t}{SE_A}$$

For all the samples, penetration depth was evaluated using above relation. Interestingly, we have found that all samples have comparable penetration depth in the range 1 to 3 mm. PoTCF50 which show a maximum SE of 23 dB at a thickness of 2.11 mm show a penetration depth of ~1 mm as shown in figure S4. Therefore thickness of POTCF50 is greater that the penetration depth.
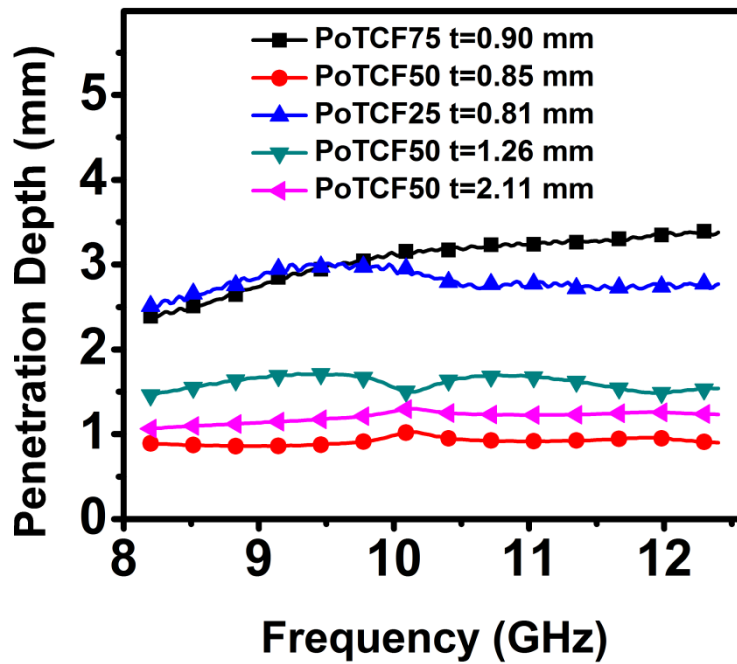
Figure S4: Variation of penetration depth as a function of frequency.