Electronic Supplementary Material (ESI) for Nanoscale Advances.

Supporting Information For

Graphene Templated Growth of Copper Sulphide 'Flowers' can Suppress Electromagnetic Interference

Devansh Sharma[1], Aishwarya V. Menon[2], Suryasarathi Bose[1*]

[1]*Department of Materials Engineering, Indian Institute of Science, Bangalore 560012, India*

[2]*Center for Nano Science and Engineering, Indian Institute of Science, Bangalore 560012, India*

**Corresponding author: sbose@iisc.ac.in*

S1: XRD of rGO-CuS (24 h) and rGO-CuS(3 h)

In figure S1 (a) and S1 (b), the 2θ peaks at 27°, 27.7° ,29° ,31.8° ,32.3° ,46.32° ,47.82° ,52.51° ,55.07° ,59.02° corresponds to (100) , (101) , (102) , (103) , (006) , (224) , (110) , (108) , (202) and (116) reflections respectively of hexagonal CuS which has good agreement with the reference data (JCPDS-06-0464).But in the case of rGO-CuS (3h) the peaks are broader than rGO-CuS(24 h) thus, the crystallite size is smaller which has grown in case of rGO-CuS (24 h). Also, the reduction of GO to rGO is confirmed from the characteristic broad peak at 24.4°. We can conclude that with increasing time there is no phase transformation in the rGO-CuS(24 h), although the peaks become sharper than rGO-CuS(6 h) representing increment in crystallite size.

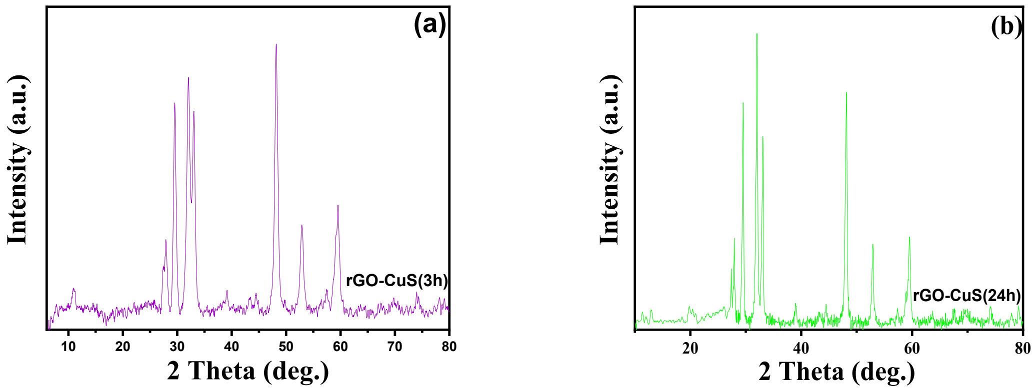

Figure S1. **(a)** XRD for rGO-CuS (3h) **(b)** Raman data for rGO-CuS (24 h)

S2: Raman analysis of rGO-CuS(24 h)

From figure S2 we observed that the I_D/I_G ratio for rGO-CuS(24 h) increases from 1.16 to 1.24 signifying there are more defects in rGO-CuS(24 h) than pristine GO.

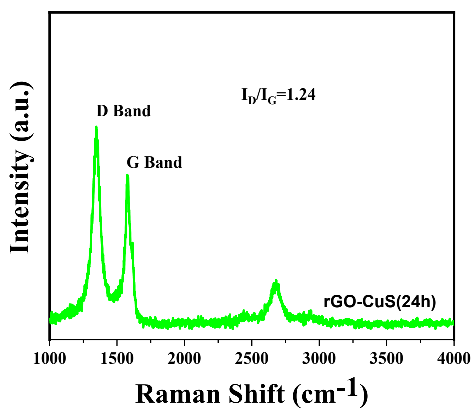

Figure S2. Raman data for rGO-CuS (24 h)

S3: AC electrical conductivity for various composites

Figure S3 shows the percolation threshold of MWCNTs in PVDF matrix. We can observe the percolation threshold is between 0.5-1 wt %. From table S1 we can see that, as the percentage of

MWCNT increases more conducting paths forms leading to an increase in conduction through tunneling; therefore, the exponent also decreases. In the case of rGO and CuS, since both are semiconducting the power-law exponent is close to 1, representing that there are a fewer conducting path and primary charge transport takes place through hopping.

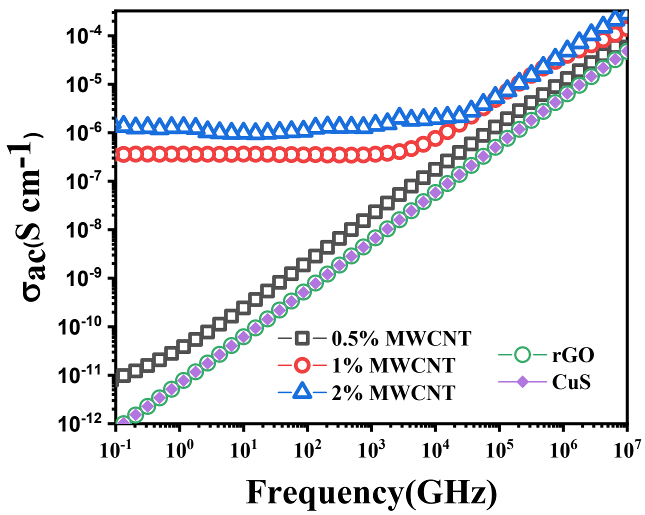

Figure S3. Electrical conductivity for PVDF composites

Table S1: Exponent fitting for the various sample.

Sample	Exponent (*n*)
0.5% MWCNT	0.92
1% MWCNT	0.88
2% MWCNT	0.82
rGO	0.96
CuS(6 h)	0.97

S4: EMI shielding performance of PVDF+MWCNT composites

Figure S4, shows that the EMI shielding performance for the control batches in which PVDF was blended with 0.5 wt%, 1 wt% and 2 wt% MWCNT. We observed that the shielding effectiveness increases with the increasing concentration of MWCNT from -10 dB for 0.5 wt% MWCNT to -20 dB for 2 wt% MWCNT at 18 GHz. This enhancement in shielding property can be attributed to the increase in conductivity of the composite with the increasing concentration of MWCNT, which can be concluded from figure S4.

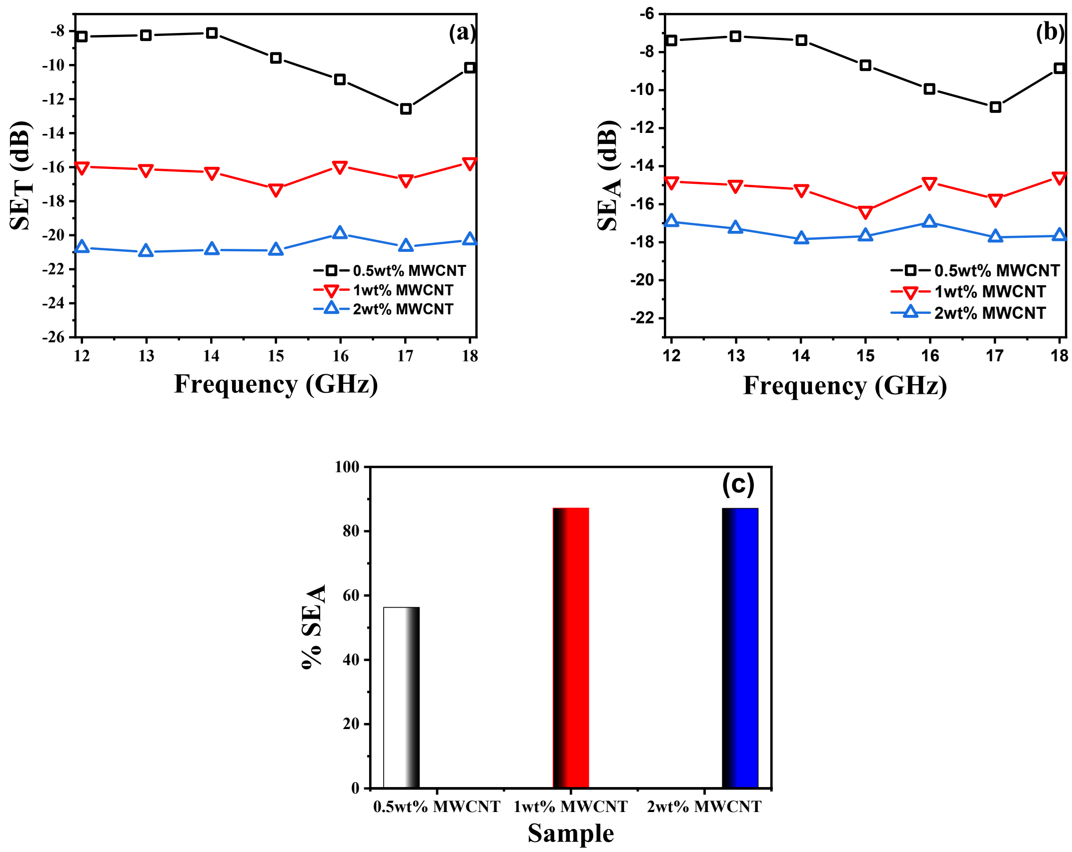

Figure S4. (a) Total Shielding effectiveness (SE_T) **(b)** Absorption (SE_A) and **(c)** % Absorption parameter for PVDF+MWCNT composite with 0.5wt%, 1wt% and 2wt% concentration

S5: Shielding effectiveness for rGO-CuS(24 h) and rGO-CuS(24 h) +MWCNT

From figure S5(a) we can see that the shielding ability of rGO-CuS(24 h) is -14 dB which increases to -22 dB after the addition of MWCNT in case of rGO-CuS(24 h) +MWCNT due to increase in charge transport. With the addition of MWCNT into the PVDF matrix along with rGO-CuS(24 h) hybrid structure results in enhancement of shielding property due to the formation of conducting bridge between different rGO-CuS particles. Also, the shielding effectiveness for rGO-CuS(24 h) +MWCNT was -22 dB which is less in comparison to rGO-CuS(6 h) +MWCNT which was -25 dB.

From figure S5(b) we can conclude that the shielding effectiveness due to absorption for composites with rGO-CuS(24 h) increases from -12 dB to -19 dB after the addition of MWCNT to composite.

We can also observe from figure S5(c) that the % SE_A is for all the three composites is quite similar which is about 84 %. However, for composites with rGO-CuS (6 h) +MWCNT the % SE_A achieved was more than 89 %. From the results, it can be concluded that the composites containing rGO-CuS (6 h) i.e. with optimally with nucleated flowers on rGO sheets show better EM shielding performance.

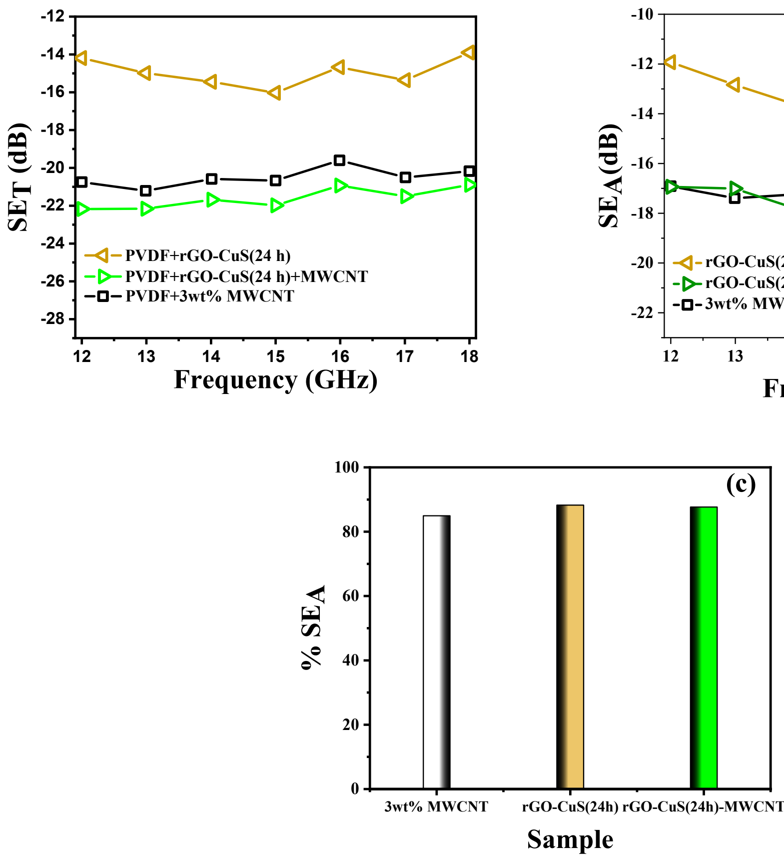

Figure S5. (a) Total Shielding effectiveness (SE_T) **(b)** Absorption (SE_A) and **(c)** % Absorption for PVDF+3wt% MWCNT composite, rGO-CuS(24 h) and rGO-CuS(24 h) +3wt% MWCNT

S6: Shielding effectiveness of composites with only 10 wt % rGO and CuS (6 h)

From figure S6, we can observe that the shielding ability of the EM shielding values is not consistent throughout the whole frequency range which occurs when the EM shielding values are quite low for the composites. rGO is -9.5 dB whereas -3.5 dB at 17 GHz for CuS(6 h). This is because rGO is more conducting than the CuS also because of the planar structure there is more conducting path for charge transport whereas, in the case of CuS, the connectivity between CuS heterostructures is less due to flower-like morphology. The SE_A value for rGO and CuS -5.5 and -2 dB respectively.

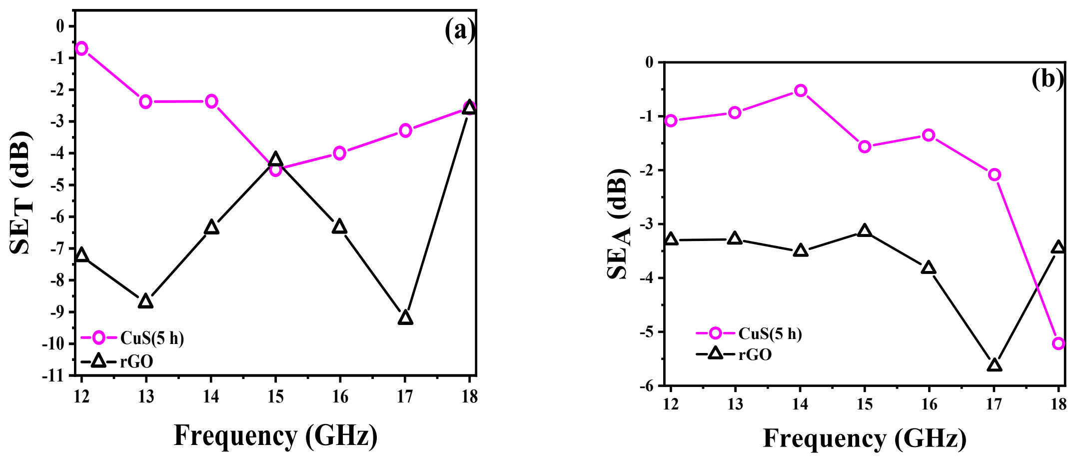

Figure S6. (a) Total Shielding effectiveness (SE_T) **(b)** Absorption (SE_A) and **(c)** % Absorption for CuS and rGO