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Supporting Information

POSS Enhanced 3D Graphene - Polyimide Film for Atomic Oxygen Endurance in Low Earth Orbit Space Environment.

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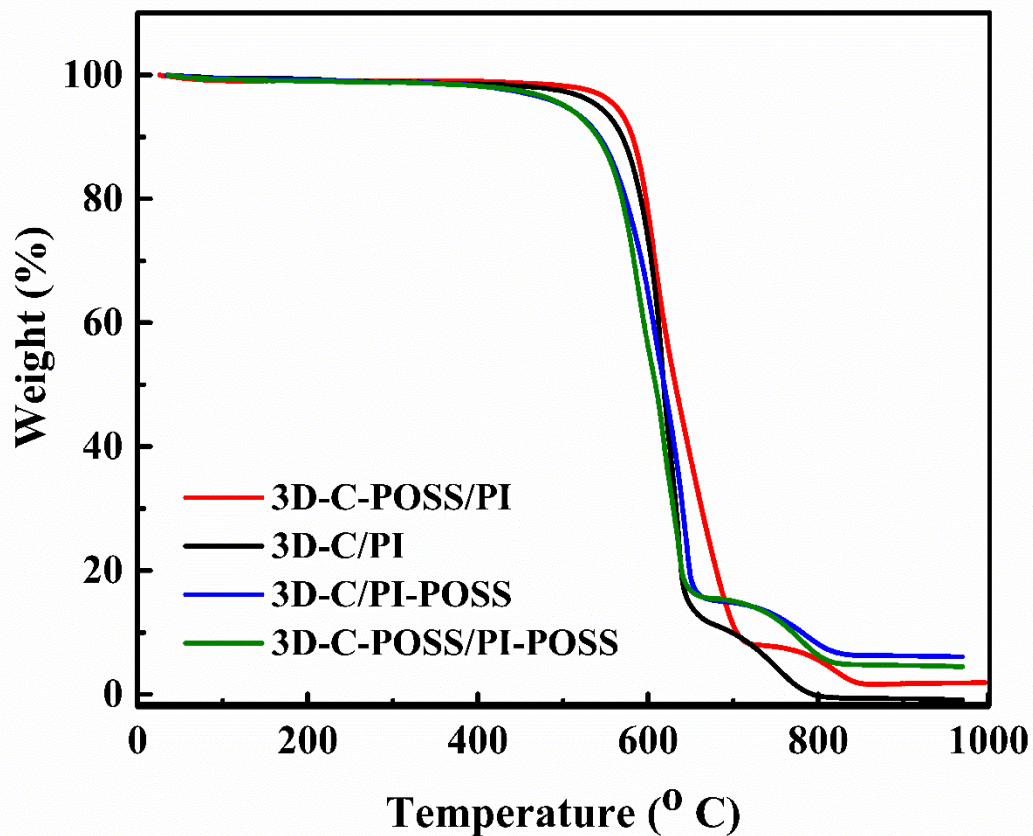


Figure S1. Thermogravimetric Analysis of 3D-C/PI/POSS composite samples under dry air atmosphere from room temperature to 1000 °C. It can be seen that Si-O structure of POSS has been formed due partial crosslinking of POSS cages resulting in residual weight for the sample with POSS in them. In addition, the composite samples with POSS in PI (3D-C/PI-POSS and 3D-C-POSS/PI-POSS) has more Si-O residue indicating the higher amount of POSS in these films compared to 3D-C-POSS/PI.

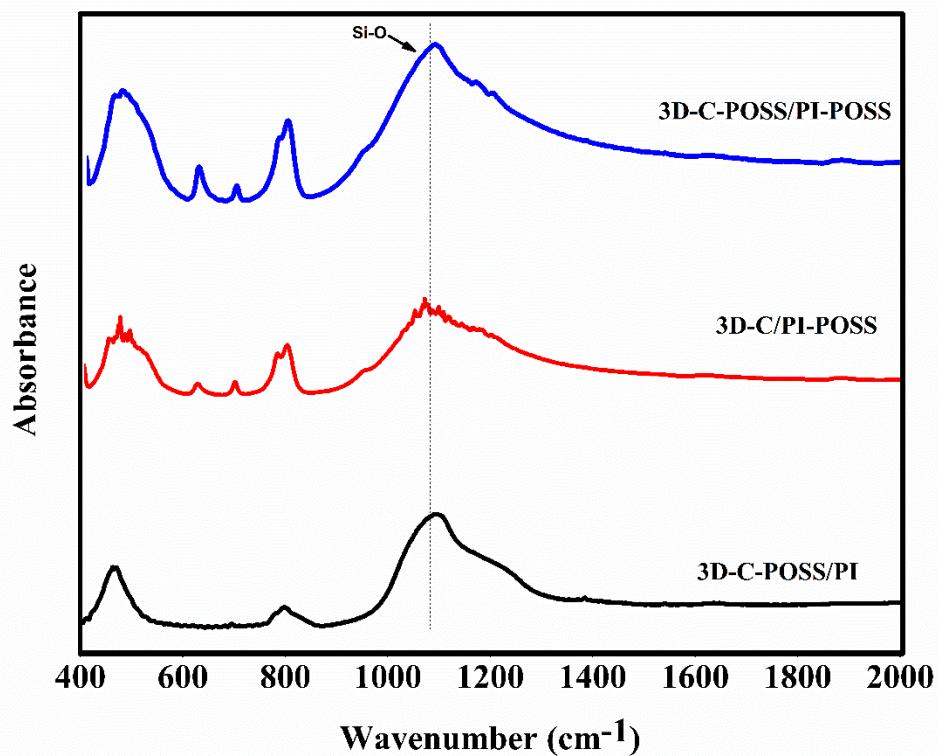


Figure S2. FTIR spectra of the residual form TGA of 3D-D-POSS/PI, 3D-C/PI-POSS and 3D-C-POSS/PI-POSS showing a broad band from Si-O stretching and the center of the absorption band at 1090 cm⁻¹ conforming the formation of Si-O structure.

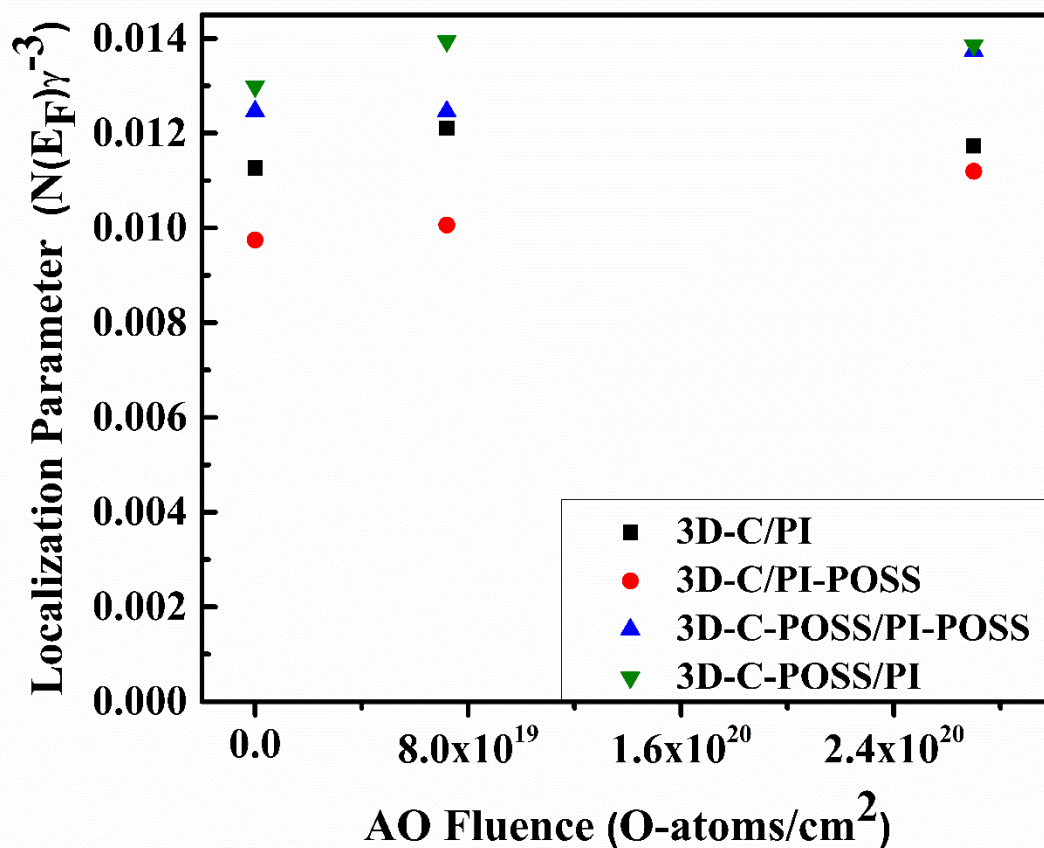


Figure S3. The localization parameter ($N(E_F)\gamma^{-3}$) values, extracted from the linear fit to the Godet VRH model, as a function of the atomic oxygen exposure fluence.

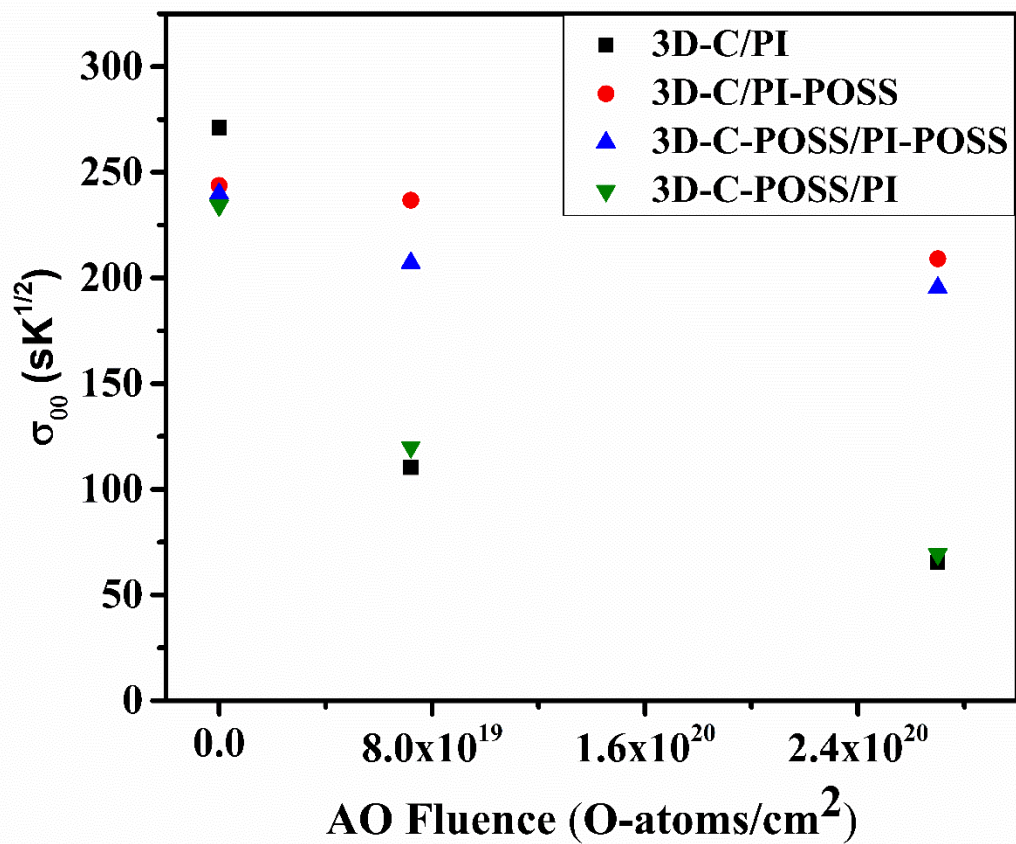


Figure S4. The exponential prefactor σ_{00} values, extracted from the linear fit to the Godet VRH model, as a function of the atomic oxygen exposure fluence.

Table S1. Stress – strain measurement results for composite samples.

	Stress at break (MPa)	Strain at break (%)	Young's modulus (MPa)
3D-C/PI	4.61 ± 0.62	6.45 ± 1.54	164.12 ± 8.36
3D-C/PI-POSS (5 wt%)	6.52 ± 1.64	4.44 ± 2.24	287.1 ± 27.76
3D-C/PI-POSS (15 wt%)	5.42 ± 0.58	5.79 ± 1.45	188.62 ± 20.53
3D-C-POSS/PI (5 wt%)	5.18 ± 0.63	7.62 ± 1.64	116.16 ± 14.65
3D-C-POSS/PI-POSS (5 wt%)	4.41 ± 1.43	3.58 ± 2.1	215 ± 31.45
3D-C-POSS/PI-POSS (15 wt%)	5.19 ± 0.39	6.64 ± 1.14	178.46 ± 9.9
Pure PI	88.3 ± 15	52.3 ± 11	1979 ± 42
PI-POSS (5 wt%)	73.41 ± 20	44.6 ± 8	2127 ± 37