Supplementary Materials:

CeO_2@Graphene acting as effective radical scavenger for protecting epoxy composites under Gamma irradiation environment

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Figure S1

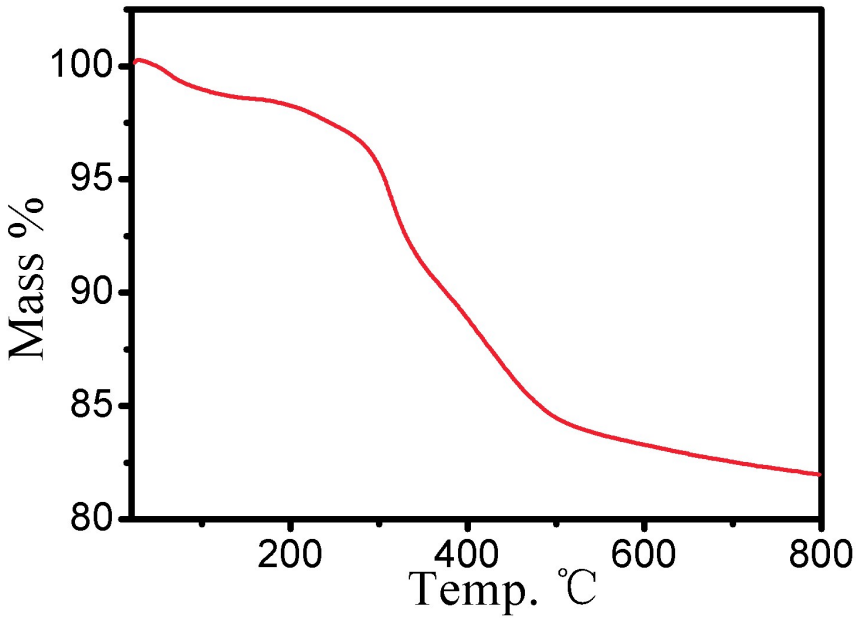

Figure S1 TGA curves of CG

Figure S1 depicted the thermo gravimetric analysis (TGA) of the CG, which under air atmosphere at a heating rate of 10 ℃ min^{-1}. TGA was also carried out to estimate the mass fraction of CeO_2 in CG. Around at 110 ℃ the weight loss was assigned to the removal of residual water in the sample [1]. The RGO in CG was combusted at a high temperature of 800 ℃ [2]， while about 82.3 % of the quality of CG was retained even at 800 ℃. The residue was the combusted product of ceria, the weight loss resulting from the combustion of RGO mainly took place between 300 ℃ and 400 ℃.

Figure S2

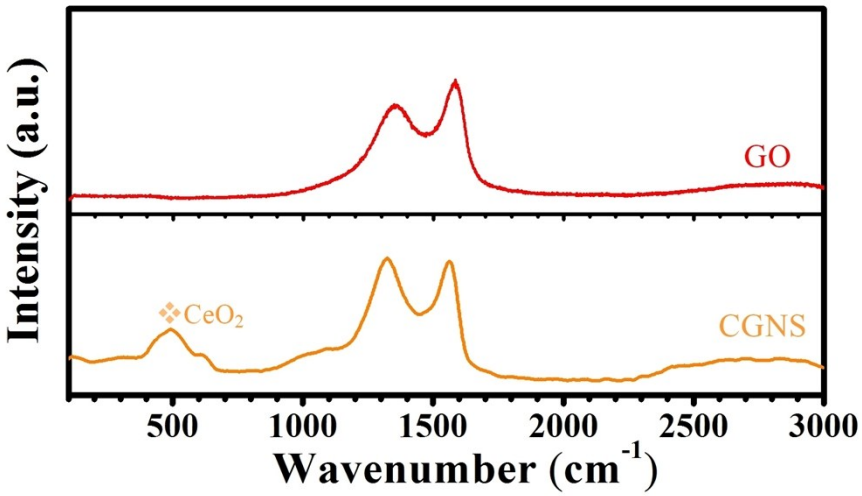

Figure S2 Raman spectra of GO and CGNS. The F_{2g} vibration mode of CeO_2 is also marked.

Figure S3

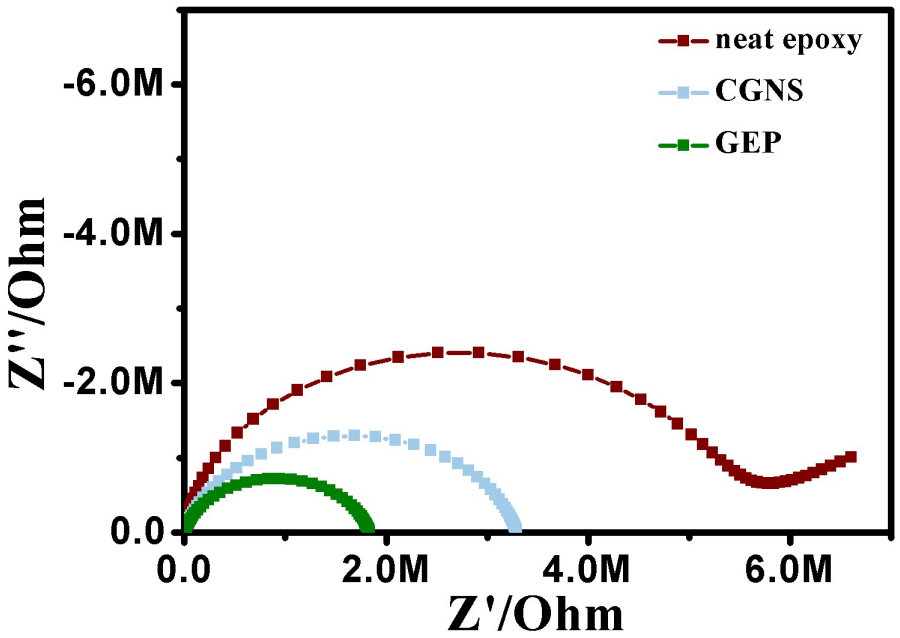

Figure S3 Nyquist plots of neat epoxy, GEP and CGNS after 200 KGy irradiated.

Figure S4

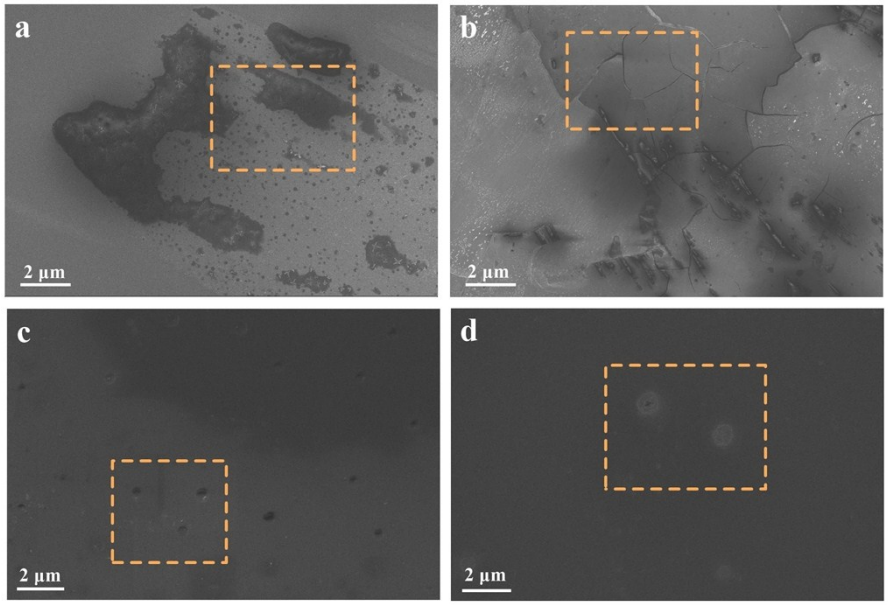

Figure S4 (a) SEM of neat epoxy after 200 KGy irradiation; (b) SEM of neat epoxy after 240 KGy irradiation; (c) SEM of GEP after 240 KGy irradiation; (d) SEM of neat CGNS 240 KGy irradiation.

Figure S5

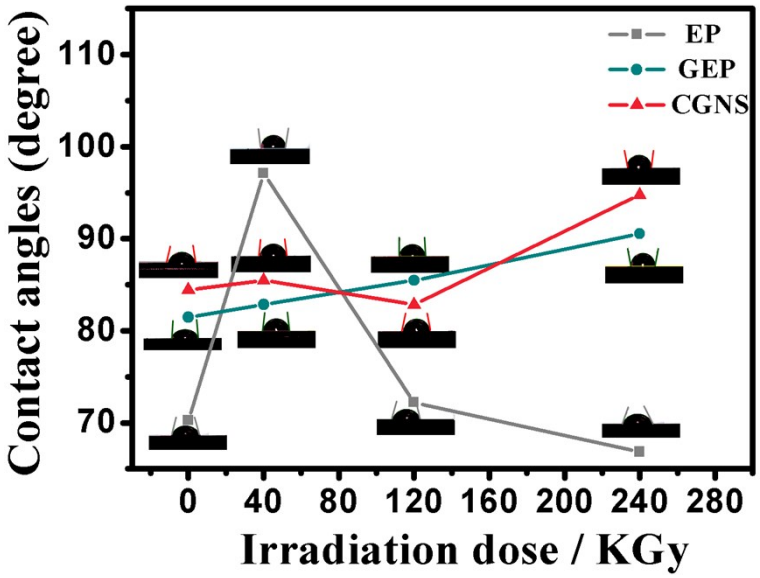

Figure S5. Water contact angles after different doses of γ irradiation.

Figure S5 shows the relationship between water contact angles onto three different films surface (EP, GEP and CGNS) and the irradiation doses. The surface of the film deposited EP had a water contact angle of ca. 70.26° and was shown to be hydrophilic. In contrast, when the irradiation dose was over 40 KGy, the water contact angles of the surfaces were more than 97.12°, resulting in the hydrophobic surface as shown Figure S4. This result indicates that gamma irradiation might induce crosslinking density [3], so as to reduce the hydrophilic groups which on the surface of EP, such as hydroxy, carboxyl. As a result, the water contact angles of EP improved a lot from 70.26° to 97.12° at the dose of 40 KGy. However, the water contact angle value of EP gets into fast decline for the accumulated radiation damage during the irradiation dose from 120 KGy to 240 KGy. We consider the possibility that the observed phenomenon was caused by radical scission of C-O and C-C bonds [4], and the radicals might be induced by the gamma irradiation. Finally, the surface water contact angle of EP drop down to 66.84° at the final dose of

240 KGy. Conversely, the water contact angles of GEP and CGNS changed little during the irradiation dose from 40 KGy to 240 KGy. These processes confirm that graphene and CG have the similar ability to maintain the efficiency of the crosslinking density.

REFERENCES

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