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Graphene-incorporated dielectric composites by varying the mixing method and degree of oxidation of graphene

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To obtain high-performance dielectric properties of dielectric composites, graphene and barium titanate ($BaTiO_3$, BTO) fillers were mixed in the polymer matrix, by varying the degree of reduction of graphene and the mixing method. Two kinds of graphene materials, i.e., graphene oxide (GO) and reduced graphene oxide (rGO); and two kinds of mixing methods for graphene and BTO, i.e., encapsulation of BTO in graphene and subsequent mixing, and simple mixing of BTO and graphene in the polymer matrix. This yielded to four kinds of graphene-incorporated samples, which was compared with the reference sample, i.e., a sample with only BTO fillers in the polymer matrix without graphene. Encapsulation process was performed by the self-assembly of positively functionalized BTO and negatively functionalized GO. After the encapsulation, GO-encapsulated BTO fillers were chemically reduced to become rGO-encapsulated BTO fillers [1,2]. All the four graphene-incorporated samples exhibited better dielectric constant values, i.e., 1.5 to 2.2 times higher than the reference sample. It was thoughted to be caused by the presence of graphene via the interfacial polarization or micro-capacitor effects [1]. However, the increase in dielectric loss, which had frequently occurred for the simple mixing cases of conducting nano-fillers, was

successfully suppressed for the encapsulated samples. Here, the dielectric loss was controlled under lower 20%, which was caused by removal of free graphene platelets during the chemical process of the encapsulation [2]. The best performance one is the encapsulation method for rGO material. The next one is GO encapsulation case. The highest enhancement of 120% in the dielectric constant and moderate dielectric loss was obtained for rGO-encapsulation case. Therefore, we can say that encapsulation of BTO in graphene is very promising mixing method for high-performance polymer-based dielectric composite materials.

References:

[1] S.-Y. Jun et al., Carbon **199**, 23 (2022).

[2] S.-Y. Jun et al., Mater. Chem. Phys. **255**, 123533 (2020).