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PII: S0955-2219(18)30474-6
DOI: https://doi.org/10.1016/j.jeurceramsoc.2018.07.043
Reference: JECS 12011

To appear in: *Journal of the European Ceramic Society*

Received date: 7-5-2018
Revised date: 25-7-2018
Accepted date: 29-7-2018

Please cite this article as: Hu Y, Xu C, Xiao G, Yi M, Chen Z, Zhang J, Electrostatic Self-assembly Preparation of Reduced Graphene Oxide-Encapsulated Alumina Nanoparticles with Enhanced Mechanical Properties of Alumina Nanocomposites, *Journal of the European Ceramic Society* (2018), https://doi.org/10.1016/j.jeurceramsoc.2018.07.043

Electrostatic Self-assembly Preparation of Reduced Graphene Oxide-Encapsulated Alumina Nanoparticles with Enhanced Mechanical Properties of Alumina Nanocomposites

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Abstract: In this study, we employed facile self-assembly methods to synthesize reduced graphene oxide-encapsulated alumina (Al_2O_3/rGO) nanoparticles. The Al_2O_3/rGO nanoparticles were subsequently incorporated into an Al_2O_3 matrix as filler to prepare nanocomposites. The microstructural analysis showed that relatively thin rGO sheets were homogeneously dispersed in the matrix and bonded with the Al_2O_3 grains forming a three-dimensional rGO network structure. The specific structure caused the rGO sheets to be anchored and bound to the matrix grains, resulting in a high contact area between the rGO sheets and the matrix, whilst the fracture mode alteration, grain refinement and improved interfacial strength of the nanocomposites were related to the unique structure. The results indicated that the nanocomposites with 2.5 vol.% rGO exhibited outstanding mechanical properties, increasing both the flexural strength by 105%, with a maximum value of 636 MPa, and the fracture toughness by 90% (5.9 $MPa \cdot m^{1/2}$) when compared with monolithic Al_2O_3.