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Modified Graphene Oxide in Ceramic Composite

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Abstract : At present intensive scientific researches of ceramics, cermets and metal alloys have been conducted for improving materials physical-mechanical characteristics. In purpose of increasing impact strength of ceramics based on alumina, simple method of graphene homogenization was developed. Homogeneous distribution of graphene (homogenization) in pressing composite became possible through the connection of functional groups of graphene oxide (-OH, -COOH, -O-O- and others) and alumina superficial OH groups with aluminum organic compounds. These two components connect with each other with -O-Al–O- bonds, and by their thermal treatment (300–500°C), graphene and alumina phase are transformed. Thus, choosing of aluminum organic compounds for modification is stipulated by the following opinion: aluminum organic compounds fragments fixed on graphene and alumina finally are transformed into an integral part of the matrix. By using of other elements as modifier on the matrix surface (Al2O3) other phases are transformed, which change sharply physical-mechanical properties of ceramic composites, for this reason, effect caused by the inclusion of graphene will be unknown. Fixing graphene fragments on alumina surface by alumoorganic compounds result in new type graphene-alumina complex, in which these two components are connected by C-O-Al bonds. Part of carbon atoms in graphene oxide are in sp3 hybrid state, so functional groups (-OH, -COOH) are located on both sides of graphene oxide layer. Aluminum organic compound reacts with graphene oxide at the room temperature, and modified graphene oxide is obtained: R2Al-O-[graphene]–COOAlR2. Remaining Al–C bonds also reacts rapidly with surface OH groups of alumina. In a result of these process, pressing powdery composite [Al2O3]-O-Al-O-[graphene]–COO–Al–O–[Al2O3] is obtained. For the purpose, graphene oxide suspension in dry toluene have added alumoorganic compound Al(iC4H9)3 in toluene with equimolecular ratio. Obtained suspension has put in the flask and removed solution in a rotary evaporate presence nitrogen atmosphere. Obtained powdery have been researched and used to consolidation of ceramic materials based on alumina. Ceramic composites are obtained in high temperature vacuum furnace with different temperature and pressure conditions. Received ceramics do not have open pores and their density reaches 99.5 % of TD. During the work, the following devices have been used: High temperature vacuum furnace OXY-GON Industries Inc (USA), device of spark-plasma synthesis, induction furnace, Electronic Scanning Microscopes Nikon Eclipse LV 150, Optical Microscope NMM-800TRF, Planetary mill Pulverisette 7 premium line, Shimadzu Dynamic Ultra Micro Hardness Tester DUH-211S, Analysette 12 Dynasizer and others.

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