THE DEVELOPMENT OF SILICA NANOPARTICLES FROM SAND MINES AS REINFORCEMENT FOR IRON BASED METAL MATRIX COMPOSITES

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ABSTRACT

Being abundant in various degrees of purity in Tronoh mineral resources, silica sand has not found any effort to process it into a usable state considering the various applications it could be used in industry. It in fact finds applications only in its pure and fine particles form –particularly in the nanoscale. The present study in turn aims to reduce the particle size and purify the naturally occurring silica sand from Tronoh mineral resources to nanoparticles size using the low-speed ball milling process and then to utilize these silica sand nanoparticles for the production of iron-based silica sand nanoparticles composites. It is observed that the low speed ball milling process, apart from reducing the particles size, increases the wt. % purity of silica as obtained in the Tronoh silica sand. The size of the processed silica sand nanoparticles was analyzed by ZetaSizer nanoparticles analyzer and FESEM analysis and found to average less than 60 nm. Iron based silica sand nanoparticles are composite of 5, 10, 15 and 20 wt. % of the processed silica sand nanoparticles developed through powder metallurgy technique and sintered at 900°C, 1000°C and 1100°C. The results then show that the addition of silica sand nanoparticles to iron as reinforcement decreased the green density albeit with an improvement observed in the sintered densities. It is also observed that the increase in the sintering temperature results in an improvement of microstructure and microhardness of the composites. The maximum hardness of 168HV in iron based composites was found with the addition of 20wt.% of silica sand nanoparticles at 1100°C sintering temperature. Microhardness was also measured on different phases of the Fe-SiO_2 nanoparticles composites. It was found that silicon-rich phase has more hardness compared to iron-rich one. The results of microhardness are verified by FESEM analysis by measuring the diagonal length of the indenter produced for both phases. It is proposed that the mechanism for the occurrence of this observed increment in microhardness is due to diffusion of silicon from silica sand nanoparticles into iron phase of the composites, resulting in the formation of pearlite and Fe_2SiO_4 phases.