

The effect of milling conditions on morphology and grain size of Al/SiC nanocomposite powders produced by mechanical alloying method

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Abstract

In the present study, high energy ball mill has been conducted to produce aluminum matrix composite powders reinforced with silicon carbide (SiC) at different milling time. To evaluate the role of milling conditions on morphology and grain size of Al/SiC composite, the material has been fabricated at different amount of SiC, i.e. 0, 2.5, 5 Wt% in two conditions (micrometric and nanometric SiC) and different milling time. For the purpose of powders investigation, SEM, XRD test and sieve shaker were used.

The results of x-ray patterns show the grain size of Al in composite powders depends strictly on both SiC content and milling time(1). The size of SiC powders shouldn't ignore. Results show that increase in milling time, will cause to reduction the grain size of matrix(fig1). The reason can be referred to this point that with increasing milling time, in powder particles severe deformation will be happen and deformation causes to production the crystalline defects such as dislocations and other defects. So the existence of dislocations leads to increasing the energy of system and for reduction the energy, dislocations form subgrains(2). Increasing in SiC(nano) percent, leads to convert the welding mechanism to fracture and so the grain size reduces(fig2). A faster grain refinement for Al/SiC composite matrix with nanometric SiC in comparison micrometric, will be happen. The difference between nanometric and micrometric SiC powders is in formation of agglomerates of ultrafine particles in initial stage of milling and the fracture mechanism of ultrafine reinforcement is stronger in comparison with coarser refinement in longer milling time. With adding micrometric SiC and increasing the amount of SiC, composite powders approached the steady state condition at the shorter time(3).

The morphologies of SEM for Al-5% SiC (nano and micron reinforcement) in different times, are shown in Fig3. It can be seen that in Al-5% SiC composite powder, for nano reinforcement the particle size is increased (delay in steady state condition) and for micron reinforcement, at the first time, the particle size will be increased and then it will be reduced, indicating the welding mechanism at the first moment and fracture at the second, and further increase in the milling time leads to the morphological change to flattened particles.

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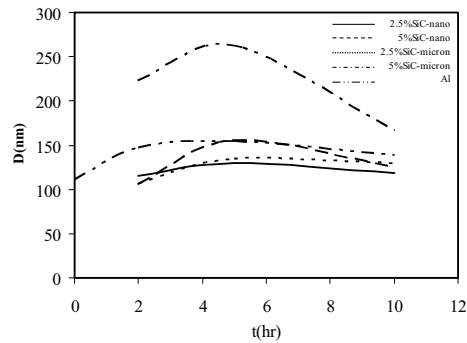


Fig1. Grain size of Al as a function of time in composite powders and pure Al powders

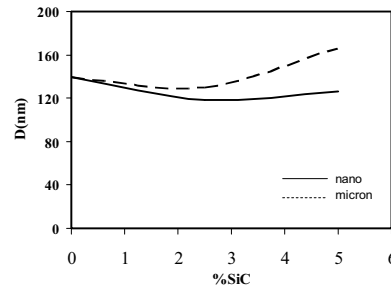


Fig2. Grain size of Al as a function of SiC percent in composite powders(t,10hrs)

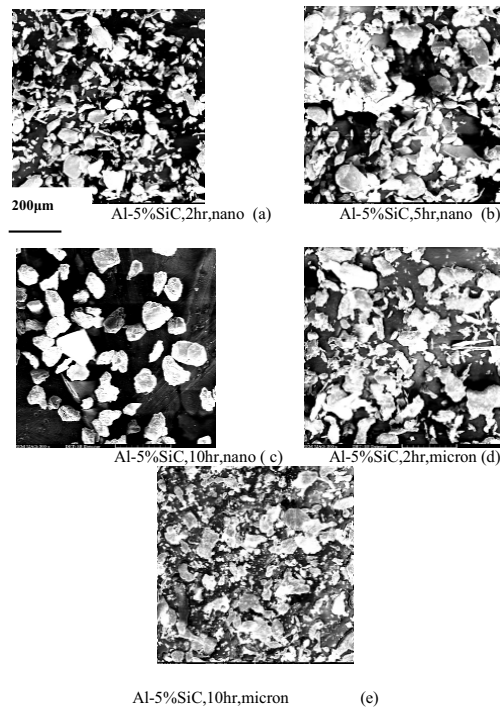


Fig 6. SEM micrographs of Al/5%SiC composite powders with (a)2hr-nano ,(b)5hr-nano,(c)10hr-nano,(d)2hr-micron,(e)10hr-micron