

초청강연 II

NANO-SIZED COMPOSITE MATERIALS WITH HIGH PERFORMANCE

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Ceramic based nanocomposite, in which nano-sized ceramics and metals were dispersed within matrix grains and/or at grain boundaries, were successfully fabricated in the ceramic/ceramic and ceramic/metal composite systems such as $\text{Al}_2\text{O}_3/\text{SiC}$, $\text{Al}_2\text{O}_3/\text{Si}_3\text{N}_4$, MgO/SiC , mullite/SiC, $\text{Si}_3\text{N}_4/\text{SiC}$, $\text{Si}_3\text{N}_4/\text{B}$, $\text{Al}_2\text{O}_3/\text{W}$, $\text{Al}_2\text{O}_3/\text{Mo}$, $\text{Al}_2\text{O}_3/\text{Ni}$ and ZrO_2/Mo systems. In these systems, the ceramic/ceramic composites were fabricated from homogeneously mixed powders, powders with thin coatings of the second phases and amorphous precursor composite powders by usual powder metallurgical methods. The ceramic/metal nanocomposites were prepared by combination of H_2 reduction of metal oxides in the early stage of sinterings and usual powder metallurgical processes. The transmission electron microscopic observation for the $\text{Al}_2\text{O}_3/\text{SiC}$ nanocomposite indicated that the second phases less than 70nm were mainly located within matrix grains and the larger particles were dispersed at the grain boundaries. The similar observation was also identified for other ceramic/ceramic and ceramic/metal nanocomposites. The striking findings in these nanocomposites were that mechanical properties were significantly improved by the nano-sized dispersion from 5 to 10 vol% even at high temperatures. For example, the improvement in fracture strength by 2 to 5 times and in creep resistance by 2 to 4 orders was observed not only for the ceramic/ceramic nanocomposites but also for the ceramic/metal nanocomposites with only 5vol% second phase. The newly developed silicon nitride/boron nitride nanocomposites, in which nano-sized hexagonal BN particulates with low Young's modulus and fracture strength were dispersed mainly within matrix grains, gave also the strong improvement in fracture strength and thermal shock fracture resistance. In presentation, the process-micro/nanostructure-properties relationship will be presented in detail. The special emphasis will be placed on the understanding of the roles of nano-sized dispersions on mechanical properties.