A formation mechanism of Al-Al_2O_3 composites by magnetic pulsed compaction

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Although nanoscale structures are expected to have peculiar properties such as high strength, super plasticity, high reactivity, and high diffusivity, many researches regarding nano compaction have not been carried out because the shaping and consolidation of nano powders are thought to be very difficult owing to the agglomeration and strong interparticle friction.

In this study, the formation of nano metal-ceramic composite compacts was investigated by the Magnetic Pulse Compaction (MPC), as a dynamic compaction, which was known as being possible to reach near theoretical density due to both sufficient pressure and adiabatic heating in a very short duration of time which is an order of micro-second. The nano-sized aluminum powders, which particle size was a range of 50 ~ 100 nm passivated in air, were compacted by magnetic pulsed pressure under 1.5 GPa for 300 □sec in the temperature ranges from 20°C to 500°C.

The grain size of compacts was maintained less than 50nm, which was analyzed by X-ray diffraction (XRD) using Scherrer method. From the calculation of adiabatic heat and pressure induced by thermal expansion, and the observation by transmission electron microscopy (TEM), it was found that Al_2O_3 could be broken and dispersed with a few nano-meter sizes in the Al matrix, and as a result, it was deduced that the homogeneous Al-Al_2O_3 composite materials was formed by the internal pressure by the adiabatic heat and the external pressure by the induced magnetic force. The ultra fine and uniform bulk structure was maintained up to 400°C of compaction temperature.