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The synthesis of Nanocrystalline (Ti,W)(C,N)-Ni pre-alloyed powder

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TiC- and Ti(CN)-based cermets have been used successfully for high precision machining operations. The control in cermet compositions and microstructure has been a common practice to improve the mechanical properties and densification behavior of Ti(CN)-Ni cermets. Recently, to omit this milling process and mix the starting powders homogeneously, the synthesis of the pre-mixed powders as WC-Co has been studied. And the synthesis of the pre-alloyed powder as (Ti,M)C or (Ti,M)(C,N) is attempted to make tough phase in a cermet system. In this study pre-alloyed nanocrystalline carbides were used to produce (Ti,W)C-Ni and (Ti,W)(C,N)-Ni cermets.

Used pre-alloyed nanocrystalline carbides were (Ti,W)C-Ni and (Ti,W)(C,N)-Ni synthesized from oxides and graphite mixture by high energy ball-milling and carbothermic reduction. Having good effect on mixing of powders and giving high energy, a planetary mill was used. After milling TiO_2, WO_3, NiO and graphite powder mixture in a planetary mill, it was found that the mixture stands at highly activated state. At 1300℃ less than conventional processing temperature(1600~2100℃), (Ti,W)C solid-solution and Ni was formed from the activated mixture. Nitrogen atmosphere was used to synthesize (Ti,W)(C,N)-Ni pre-alloyed powder from the same activated mixture.

(Ti,W)C-Ni or (T,W)(C,N)-Ni pre-alloyed powder were synthesized and the powder size was 200~300 nm. Their crystallite sizes were calculated by Scherrer formula from X-ray diffraction and both sizes were less than 50 nm. And synthesized nano-sized carbide particles resulted in homogeneous microstructure, which is significantly different from those of conventional micron-sized systems. Microstructures sintered from pre-alloyed powder have very fine grains of ~500 nm and were non-core/rim structure.

Conclusively, Nanocrystalline (Ti,W)C-Ni and (Ti,W)(CN)-Ni powders synthesized from oxides resulted in homogeneous microstructure of 200-800nm. Mechanical properties of the specimens of nanocrystalline (Ti,W)C-Ni and (Ti,W)(CN)-Ni powders would be significantly different from those of micron-sized systems if full density of nano cermets can be obtained. It was found that (Ti,W)(CN)-Ni was unstable compared to (Ti,W)C-Ni due to the co-existence of W and N.

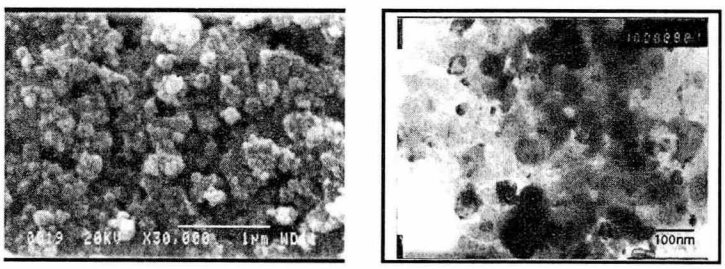

Fig. 1 SEM and TEM micrographs of (Ti,W)C-Ni pre-alloyed powders.

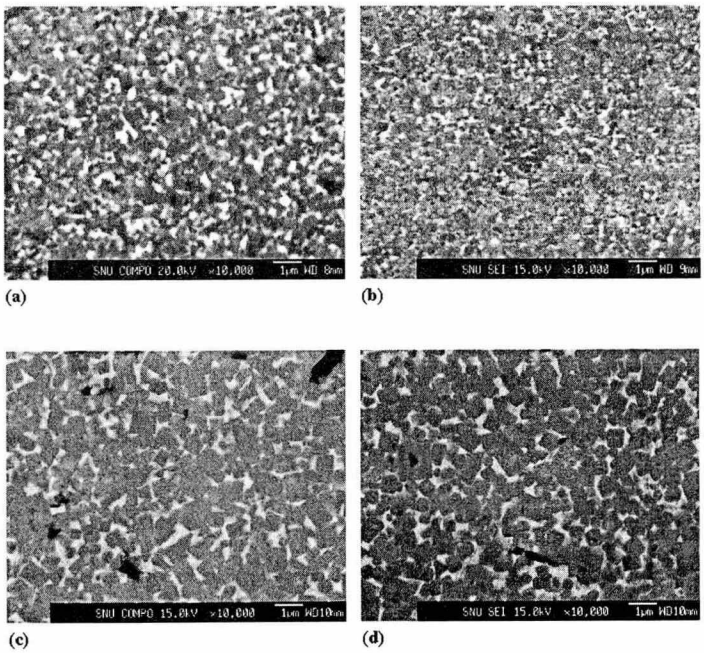

Fig. 2 FE-SEM images of the cermets from nano powders: (a), (b) (Ti,W)C-Ni obtained from 15, 30 wt.% WC, respectively and (c), (d) (Ti,W)(C,N)-Ni obtained from 15, 30 wt.% WC, respectively.