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Microstructure and Mechanical Properties of Ultrafine Grade Ti (CN) Cermets

E. Chun, J. Joardar and S. Kang
School of Materials Science and Engineering, College of Engineering, Seoul National University, Kwanak-ku, Seoul 151-742, Korea

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Ti (CN) cermets has received major attention in the field of cutting tool materials in recent years [1]. A typical core-rim structure in the cermet is envisaged to be most critical in controlling the material properties [2]. The influence of ultrafine grade Ti (CN) on the development of the core-rim structure and its concomitant effect on the material properties has been investigated in the present work.

Microstructural evolution

Microstructural features as evolved on sintering (at 1510°C for 1h) of Ti (CN)-5WC-20Ni blends with varying Ti (CN) particle size are shown in Fig 1. The figure illustrates a typical microstructure comprising of a Ti (CN) core enveloped by a rim structure. Such structural development has been reported in earlier works [3] and has been attributed to the dissolution and subsequent reprecipitation of the saturated solutes on the undissolved Ti (CN). The figure also shows extensive rim formation in the ultrafine grade Ti (CN) (Fig. 1a) when compared to the coarse-grained grades. This reflects fast dissolution of carbides apparently due to large surface area in the ultrafine Ti (CN) particles. Considering the rim and the enclosed core as single Ti (CN) particle, it appears (Fig. 1) that there is substantial coarsening in the ultrafine grade (0.7-0.95μm), with the particle size reaching ~1.5-2μm for Ti (CN)-5WC-20Ni. However, the resulting particle size is finer than that in coarse-grained grade (Fig. 1b). The coarse 3-5μm Ti (CN) shows insignificant growth under identical sintering conditions. Such behavior is possibly in accordance with the surface energy minimization effect in the ultrafine particles. Furthermore, the ultrafine Ti (CN) seems to ensure a uniformly distributed Ti (CN) core. Such microstructural feature is expected to show isotropic behavior and enhanced material properties. The addition of higher WC showed restricted grain growth in the ultrafine grade Ti (CN). As for example, the grain size reached about 1-1.2μm in Ti (CN)-25WC-20Ni when compared to 1.5-2μm in Ti (CN)-5WC-20Ni. It possibly reflects that the extensive coarsening takes over after the fast completion of WC dissolution.

Mechanical properties

Fig.2 shows the Vickers hardness and fracture toughness values of the sintered Ti (CN) cermets. It is quite evident that the ultrafine grade shows a considerably improved hardness values when compared to the coarse grade. The present work showed that the coarse-grained samples are relatively prone to severe fracture leading to poor toughness. The improved properties of the ultrafine Ti (CN)-based cermets may be correlated to the well-developed rim structure, apart from a uniformly dispersed fine-grained structure retained after sintering.

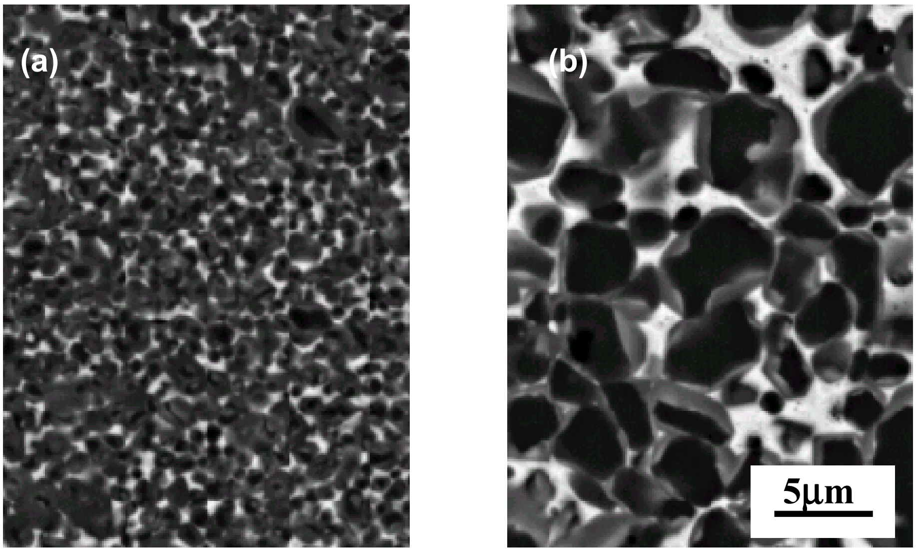

Fig. 1 Back scattered SEM images of TiCN-5WC-20Ni with TiCN partcle size of (a) 0.7-0.95µm and (b) 3-5µm

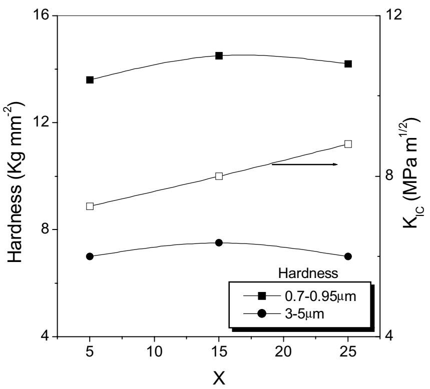

Fig. 2 Mechanical properties of Ti (CN)-XWC-20Ni cermets sintered at 1510^{o}C

References

1. H. Matsubara, S.G. Shin and T. Sakuma, Solid State Phenomena, 25(1992) 551
2. P. Ettmayer and W. Lengauer, Powder Metall., 21(1989) 37
3. M.G. Gee, M.J. Reece and B.J. Roebuck, Hard Mater., 3(1992) 119