Boron Nitride Nanotube-Metal Composites and Interface Reactions

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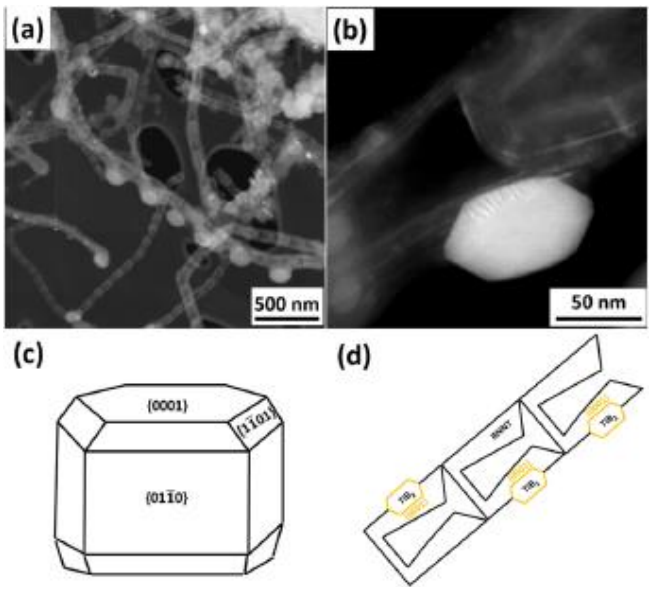
Boron nitride nanotubes (BNNTs), the seamless cylindrical structures made of hexagonal boron nitride sheets, possess excellent elastic modulus (50–1200GPa) and
strength (61 GPa). In addition, BNNTs have a high thermal stability up to 900 ^{o}C in the presence of oxygen. These unique properties of BNNTs have increased its potential as promising reinforcement to metal-based structural composites. This presentation introduces our recent research in the production of BNNT-Al and BNNT-Ti composites prepared using Spark Plasma Sintering process. 50% improvement in both yield and compressive strength with 5 vol% BNNT addition in Al matrix has been achieved.[1] These improvements are associated with the interface reactions between BNNTs and Al [2]. Faster outward diffusion of N from BN in Al leads to nucleation of AlN crystals at the outer surface of BNNT toward Al side. On the other hand, thermally activated Al atoms diffuse to the leftover B-concentrated regions to form AlB_2 in the grooves of BNNT wall. BNNT-Ti composites are prepared using cold-press and annealing processes. Compression tests both at room temperature and at 500 °C show a significant increase in the mechanical properties of the composites, compared to pure Ti.[3] TiB_2 nanocrystals firstly nucleate on the surface of nanotubes at 800 °C for 30 min. By the time 1 h, these nucleated TiB_2 crystals grow larger by consuming inner-walls of nanotubes and tend to transform into TiB phase. [4]

[1] Materials Science & Engineering A574 (2013)149–156
[2] Journal of Materials Research, 27 (21) (2012) 2760-2770
[3] Journal of Materials Research, 32 (2017) 3744
[4] Scripta Materialia 127 (2017) 108–112



Interface reaction between BNNTs and Ti