Micro and Atomic structure of the interface in advanced materials fabricated by using high pressure with shock wave

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Many materials and composites fabricated by using extremely high pressure with shock wave show high performances in their mechanical and other properties. The interfaces such as grain boundaries and interphase boundaries are one of the characters governing superior properties in those materials. Therefore, an investigation of their interfaces is very important. In this paper, we have shown some interfaces of explosively welded Al/Si_3N_4 clad and TiB_2-TiN composite fabricated by combinational process shock consolidation and self-combustion synthesis.

Figure 1 (a) shows a bright field image of an interface between explosively welded Al/Si_3N_4 clad. There is an intermediate layer between bulk Al and Si_3N_4 whose thickness is about 1μm. The average grain size of crystals in the intermediate layer is approximately 100nm. The analysis of an electron diffraction pattern taken from the intermediate layer inserted to upper-right side of Fig.1 (a) and energy dispersive spectroscopy (EDS) have revealed that layer consists of only Al single phase shown as Figure 1 (b). In addition, there are no secondary phase such as precipitation and amorphous around the interface. Comparing of some reports about bonding interfaces [1], we can consider that the formation of Al nanocrystalline layer is due to melting and rapid solidification with explosively welding.

Figure 2 (a) shows a bright field image of shock consolidated TiB_2-TiN composite. We have confirmed the dual phase microstructure consisting of TiB_2 and TiN phase. Figure 2 (b) shows a high resolution image of an interphase between TiB_2 and TiN. TiB_2 and TiN have specific crystallographical orientation relationship, which is $\{0001\}_{TiB2}$ // $\{111\}_{TiN}$ and $<11\bar{2}0>_{TiB2}$ // $<110>_{TiN}$. This orientation relationship is parallel to close packed plane and direction to each other. Therefore, the interphase boundary is to be very stable interface. We have also observed a grain boundary of TiB_2 shown as Figure 2 (c). There is no secondary phase in the grain boundary on an atomic level. In this composite, we can predict that the observed smooth interphase boundary and directly bonded grain boundary must provide the superior mechanical and chemical properties at elevated temperature.

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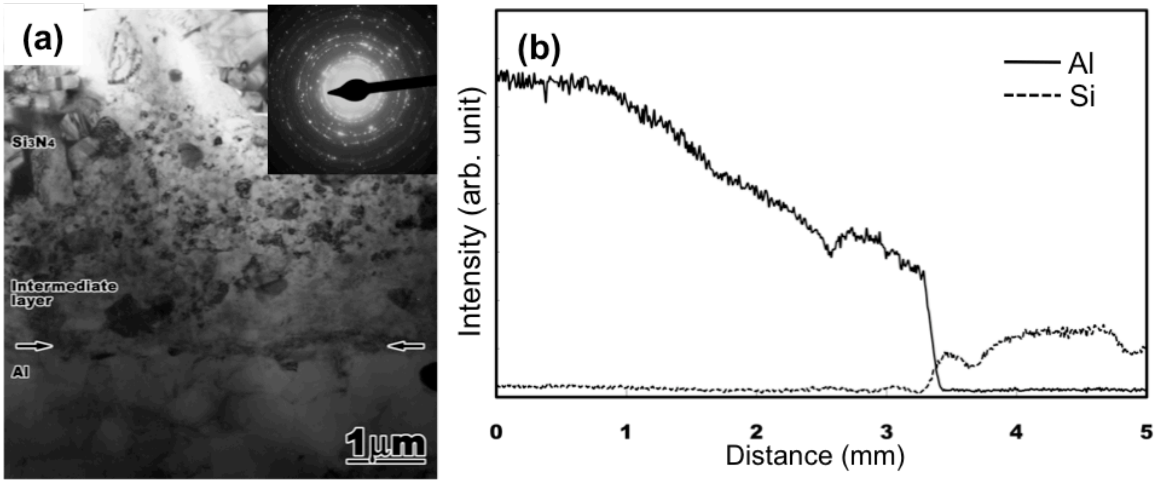

Figure 1. (a) Bright field image of the interface of explosively welded Al/Si_3N_4 clad materials. Selected area electron diffraction pattern taken from the intermediate layer is inserted to upper-right side of (a). (b) Energy dispersive spectroscopy spectra of Al and Si taken across the bonding interface in Al/Si_3N_4 clad.

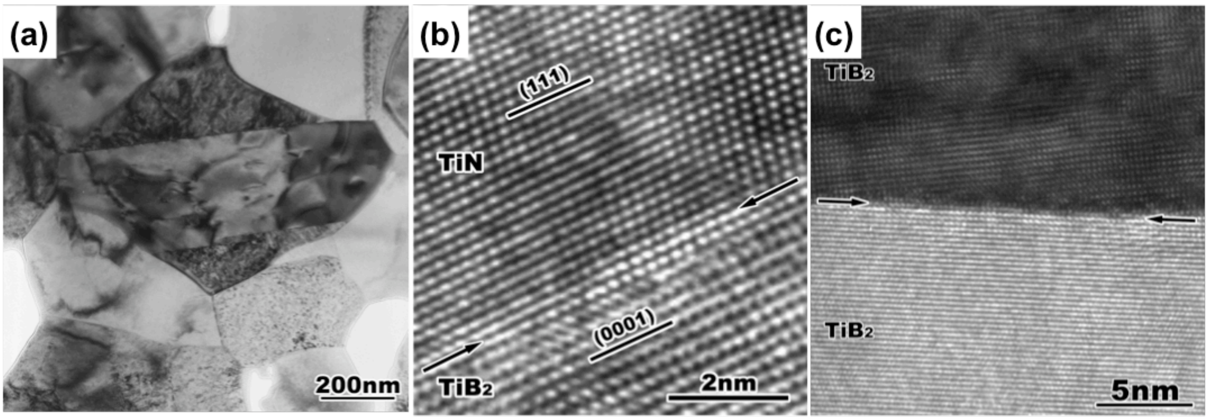

Figure 2. Micro and atomic structure of 60 mol% TiB_2-40 mol% TiN composite fabricated by combination process of self-combustion synthesis and shock consolidation, showing a bright field image (a), high resolution electron micrograph of the interphase boundary of TiB_2 and TiN (b) and high resolution electron micrograph of the grain boundary of TiB_2 (c), respectively.

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