Fracture and property relationships in the double diboride ceramic composites via spark plasma sintering of TiB_2 and NbB_2

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Supplementary data.

(tentative – I will decide before submission)

In this appendix, flexural strength dependence of the specimen #77b, when the formation of the solid solution between TiB_2 and NbB_2 phases was achieved during SPS at 2000 °C, 100 °C/min heating rate, and constant pressure of 60 kN. Before SPS, phases were mixed in a 1:1 molar ratio.

After consolidation specimen was subjected to procedures listed in *section 2*. It was identified by XRD that the a single phase was obtained (PDF #65-8691), and a typical grain size was between 6 and 30 μm (see **Fig. S2.1**).

Flexural strength using a three point method was evaluated using three specimens for each temperature (**Fig. S2.2)**. Highest strength value reported at 1800 °C, 212 MPa, almost twice smaller than that at room temperature (398 MPa). Although $(Ti0.5Nb0.5)B_2$ ceramic had grain size comparable to phase in composites #97–#99, flexural strength decreased gradually with increase in temperature, followed by a significant decrease at 1800 °C. Clearly, in a rough approximation the results for the specimen #77b follow the same trend as was observed for the TaB2 – ZrB2 specimen in [27]. Nevertheless, in the case of the specimen #77b, load –

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displacement curves with typical plastic behavior were identified at 1600 °C, while in [27], and in the case of the #97 – #99 DDCCs, curves with elastic behavior were observed.

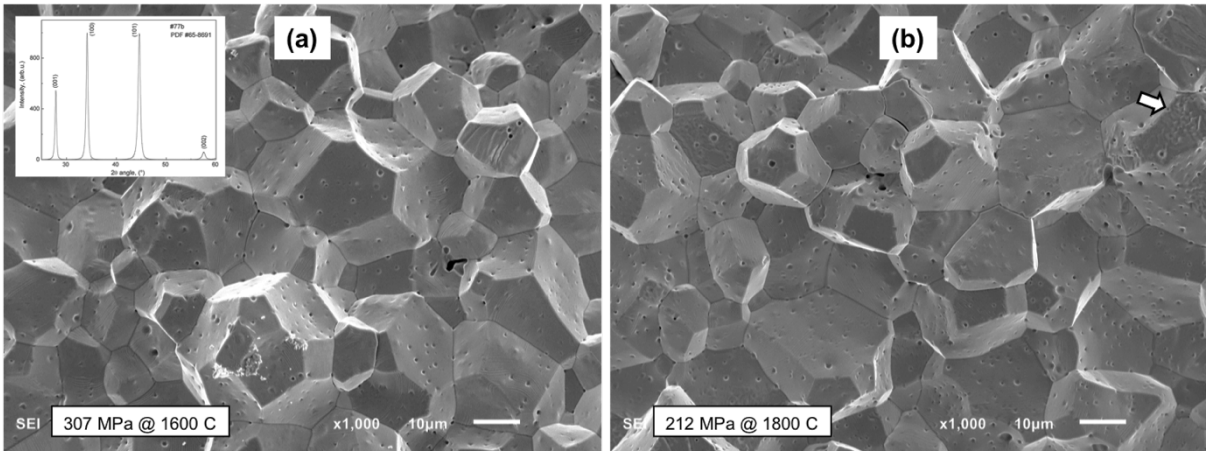

Figure S2.1. – Microstructure of the specimen #77b after flexural strength tests at (a) 1600 and (b) 1800 C. Inset in (a) shows results of the XRD, all peaks were identified as a single phase (#65-8691). Arrow in (b) shows an area which most likely a consequence of the creep-induced fracture / sliding. Mind, the typical pore size for this specimen was ~ 1 μm, thus it is likely that a significant number of voids were formed during the fracture process at elevated temperatures. Presence of the marking on the surface is most likely due to surface diffusion or argon etching during flexural test [34].

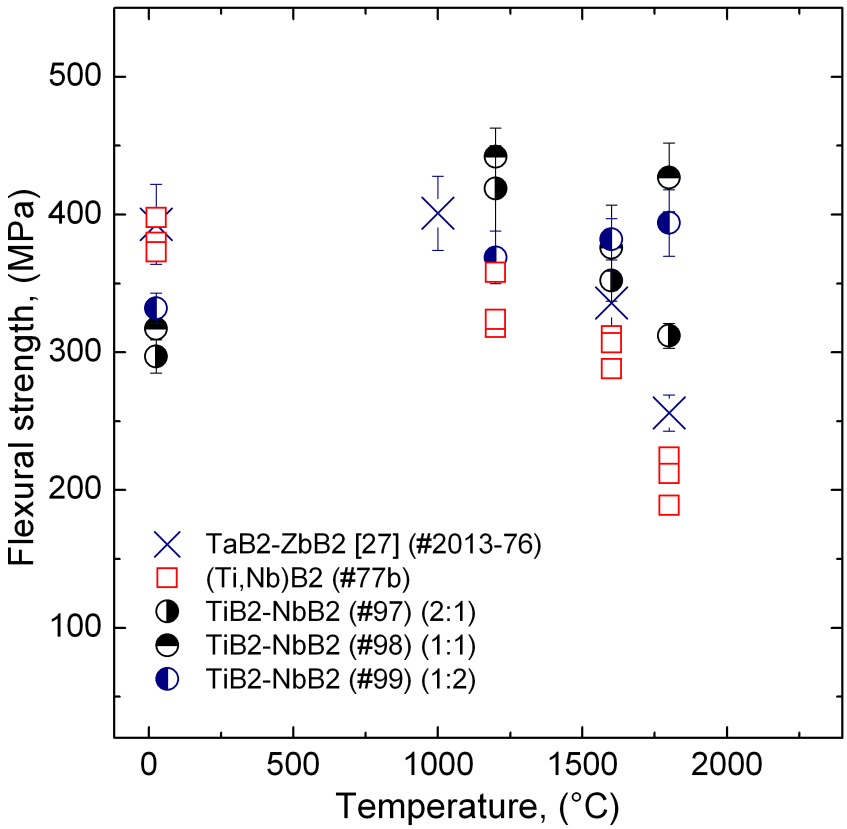

Figure S2.2. Effect of temperature on the flexural strength of (Ti,Nb)B_2 phase consolidated by SPS at 2000 °C. Despite slightly higher strength at room temperature, comparable to that in [27] for TaB_2-ZrB_2, a gradual decrease in flexural strength at elevated temperatures was observed.