



# Properties of Titanium Matrix Composites Reinforced with Titanium Boride

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## Abstract

- The application of this consolidation processing, reduced the number of processing stage to 4
- As TiB<sub>2</sub> reinforcements in the TMC ↑:
  - grain size ↓
  - pores ↓
  - hardness ↑
  - amount of reinforcements ↑
- Change in microstructures with the addition of TiB

## Background

### About TMC valves

- Matrix: **TiH<sub>2</sub> + Near Alpha**
- Reinforcement: **Micro TiB<sub>2</sub> Particulates (3 wt%)**
- Processing: **Powder Metallurgy (PM) + Extruding + Forging**
- More than 500,000 PM-TMC valves has been produced

### TiH<sub>2</sub> as starting material

- More cost effective than titanium powder in fabrication process
- Low adherence with the metal die during cold pressing
- Oxygen content is lower than that of the CP titanium

### TiB<sub>2</sub> as reinforcements

- Stiffness is over four times higher than titanium alloys
- Thermodynamic equilibrium with titanium alloys
- A similar coefficient of thermal expansion (8.6x10<sup>-6</sup>/°C) as that of titanium (9.7x10<sup>-6</sup>/°C)

TiB<sub>2</sub> is formed by in-situ reaction between TiB<sub>2</sub> and Ti

## Experimental Procedure

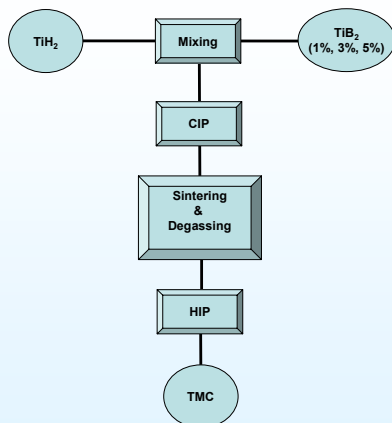


Figure 1. Experimental Procedures

## Results

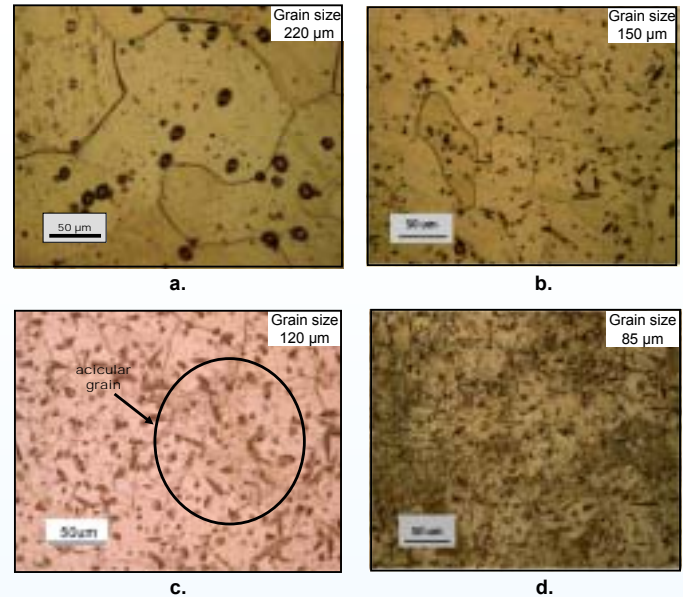


Figure 2. OM images of (a). Pure titanium; (b). TMC with 1%TiB<sub>2</sub> addition; (c). TMC with 3%TiB<sub>2</sub> addition (acicular microstructure within grains) and (d). TMC with 5%TiB<sub>2</sub> addition, with fully acicular structure. All samples have been sintered



Figure 3. OM images of sintered and HIPped of pure titanium

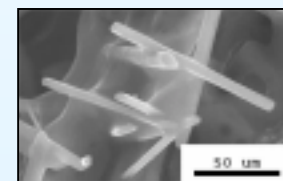


Figure 4. Welding SEM image observed in TMC with 5%TiB<sub>2</sub> addition

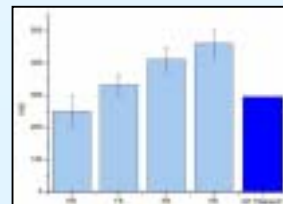


Figure 5. TMC hardness test results compared to commercially pure titanium (CP titanium)