Effect of Titanium Carbide (TiC) Content on Microstructure and Mechanical Properties of Spark Plasma Sintered Ni-TiC Composites

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INTRODUCTION

Studies have been conducted in the past on different Ni-TiC composites. This research was done to add more results and data to the existing database of past results. This data can be used for choosing material for part manufacturing, for example.

Abstract

The influence of variations in the TiC content employed during spark plasma sintering (SPS) of nickel-titanium carbide composites on its microstructure and mechanical properties has been investigated in a systematic manner. Mechanical alloying is a powerful non-equilibrium process for fabricating shapeless and nanocrystalline materials in the form of a powder. Spark plasma sintering (SPS) is a technique for processing dense and near net shape bulk alloys with homogenous microstructure. Mechanical alloying was performed using planetary high energy ball mill with ball to powder ratio 10:1 for 24 hours. Bulk Ni-TiC composites (with TiC content varying from 5 to 40 wt%) were fabricated via mechanical alloying followed by SPS at 50 MPa pressure and 1100° C temperature. These Ni-TiC composites exhibits excellent microhardness, microstructure, and tribological properties as compared to pure nickel.

Figure 1. Final Polished Sample of Ni-10TiC

OBJECTIVE

Analyze the microstructure and properties of different compositions of nickel-titanium carbide. These results can then be compared with the pure nickel sample and other mixtures.

METHODS

- Used ball mill machine to mix the powders of Pure Nickel, Ni-5TiC, Ni-10TiC, Ni-30TiC, Ni-40TiC
- The Spark Plasma Sintering (SPS) technique was used to compress the powder into a solid piece
- The compositions were mounted with graphite in a press machine
- Samples were then polished to receive a smooth, clean surface finish
- Hardness test (Vickers) was performed and electron microscope was used to examine grain structure

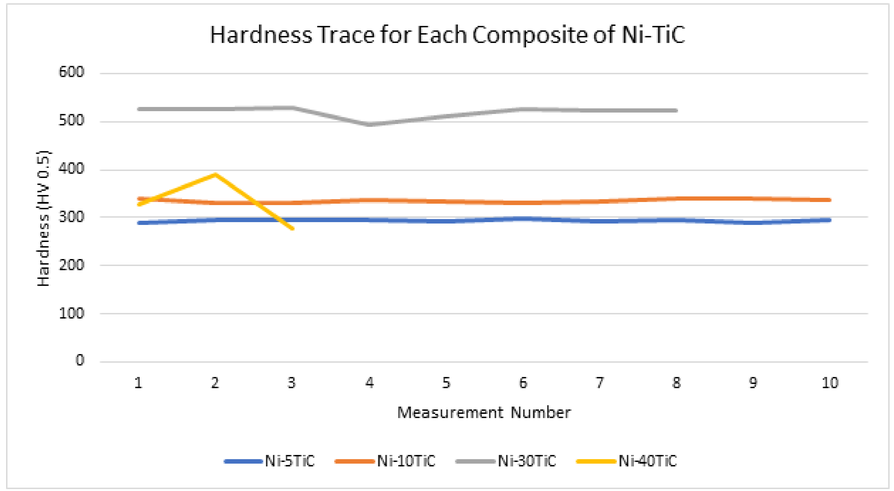

Figure 2. Graph of hardness numbers for each sample

RESULTS

- Ni-30TiC exhibited highest microhardness
- Ni-40TiC sample was not in good enough condition to attain more results (graphite layer and pits)
- Microhardness increased as Titanium content percentage increased (Ni-40TiC is an outlier)

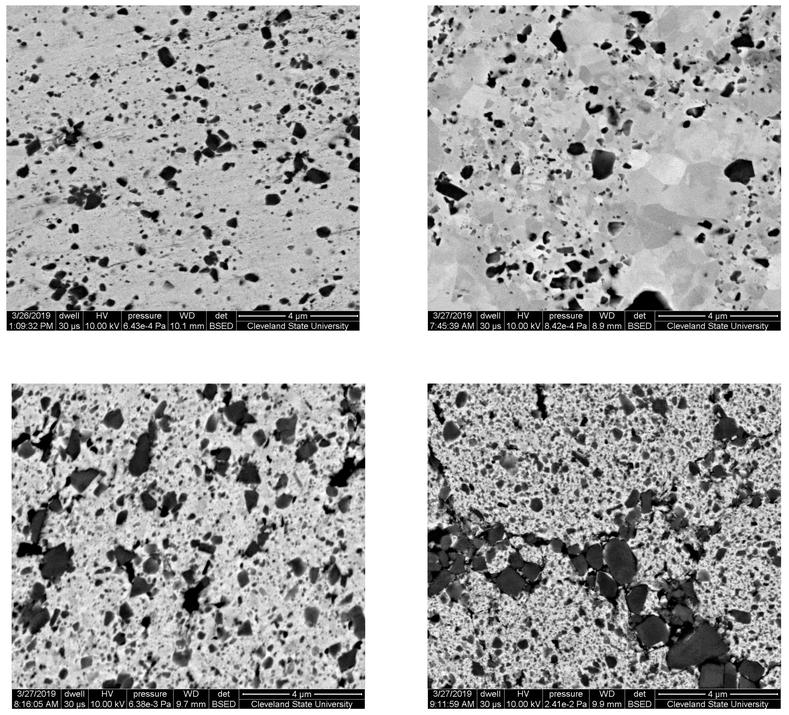

Figure 2. Electron Microscope Imaging of Grain Structure at 25k Magnification (Top Left: Ni-5TiC, Top Right: Ni-10TiC, Bottom Left: Ni-30TiC, Bottom Right: Ni-40TiC)

CONCLUSIONS

The Titanium Carbide reinforced Nickel matrix composites included pure Ni, Ni-5TiC, Ni-10TiC, Ni-30TiC, Ni-40TiC. The results show that the reinforcement has excellent microhardness and microstructure. These findings can be used in material selection for manufacturing parts.

FUTURE WORK

We can expand on these results by conducting other tests on these samples. More research can also be done by experimenting with different percentage compositions of NI-TiC systems. On top of this, research can be done on different mixtures of different elemental powders.

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