Microstructure, Properties and Heat Treatment of Steel Bonded TiC Cermets

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Abstract

The binder phase for TiC reinforced steel matrix composite was added in the form of elemental powders and master alloy powders. The microstructures, binder phase variation with TiC content and mechanical properties were evaluated. The addition of a type of binder phase largely effects the microstructure and mechanical properties. The binder phase variation from starting composition was observed with increase in wt% TiC content and this variation was higher when the master alloy powders were used as a binder. The response to heat treatment was decreased with an increase in TiC content due to the shift of binder phase from the starting composition.

Keywords : TiC- Maraging Stainless Steel Composites, Aging, Powder metallurgy, Microstructure, EDS

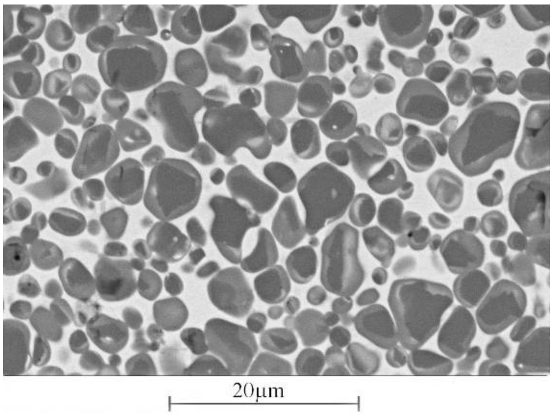
1. Introduction

High hardness, chemical inertness, respectable strength and fracture toughness, combined with a relatively low production cost make TiC- based materials one of the most widely used wear resistance composites today. Improvements in composite processing have resulted in improved materials reliability and created renewed interest in TiC- based cermets [1-5]. A second phase is used with TiC reinforcements to improve the toughness of the cermets. Due to economic reasons there is a significant interest in steels to be used as binders for TiC reinforcements [6-8].

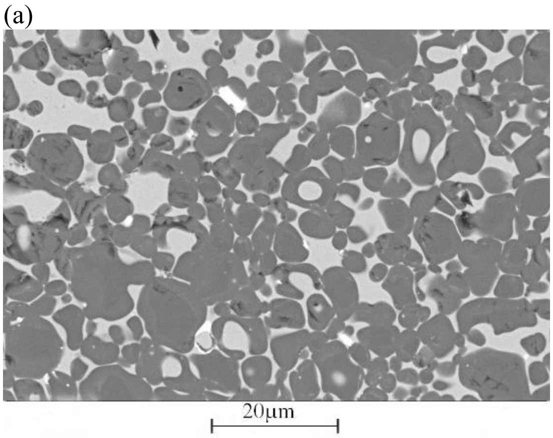
2. Experimental and Results

TiC- 465 SS composites investigated were produced through conventional press and sinter P/M. TiC powders and elemental powders and master alloy powders (Fe- Cr, Fe- Ni, Fe- Si) in the composition of 465 SS were mixed and wet milled for 72 hours. The composition of binder phase is given elsewhere [9]. The milled powders were uniaxially pressed into cylindrical compacts under a pressure of 550 MPa. Sintering of all prepared samples was performed within a high temperature vacuum furnace at 1400 ºC for 1 hour. The microstructure of these cermets was assessed by scanning electron microscopy Kavex Leo 1450. Hardness and bend strength were measured for each sintered TiC steel composites. Three separate hardness (HRA) and bend strength measurements were taken and the results averaged. The heat treatment of the cermets was carried out according to the heat treatment procedure of sintered elemental powders in the composition of 465 [9].

The microstructure of the cermets is shown in figure- 1. Figure- 1(a), 1(b) show the micrographs of TiC reinforced 465 stainless steel cermets using elemental powders and master alloy powders respectively. On comparison of these micrographs we can observe that the microstructural development was different for two kind of powders (Elemental/ Master alloy Powders) in the composition of the binder phase. The elemental powders exhibited superior wetability with TiC reinforcements compared to master alloy powders and produced a defect free microstructure. The microstructure showed the typical core rim structure developed by solution and precipitation process of C in the steel melt [1, 2]. The growth of the TiC particles during microstructural development happens at the expense of some binder elements which forms mix carbides and alters the initial composition of steel binder phase [1, 3]. By EDS analysis of binder phase it was found that in the case of elemental powders, the variation in composition of binder phase was not large and agreed well with the microstructure given in figure- 1(a). Where as, the binder composition had shifted from the original composition due to the reaction between the reinforcement and binder phase in the case of master alloy addition. An overview of the mechanical properties of the developed cermets in the study is given in table- 2. Cermets containing elemental powders showed better mechanical properties and their response to heat treatment was also better compared to the TiC reinforced 465 stainless steel cermets using master alloy powders in the composition of 465 stainless steel.



(a)



(b)

Fig. 1. (a) SEM micrograph of TiC- 465 stainless steel cermet using elemental powders in the composition of binder phase (b) SEM micrograph of TiC- 465 stainless steel cermet sing master alloy powders in the composition of binder phase.

Table 2. An overview of mechanical properties of the cermets

Wt% TiC	Wt% Binder	HRA Sintered	HRA [HT]	Bend Strength (MPa)
50	50 E	84.0	89.0	1329
60	40 E	91.6	93.7	1123
70	30 E	92.5	91.7	789
50	50 MA	84.2	87.7	1289
60	40 MA	91.0	91.2	917
70	30 MA	93.5	93.0	580

3. Summary

Two kind of binder phase addition with varying TiC content showed that elemental powders in the composition of the binder phase was a better choice to process cermets compared to master alloy powders in the composition of the binder phase. Elemental powders produced defect free microstructures, the binder phase variation with the TiC content was lower and the response to heat treatment was higher and was retained for higher TiC levels.

4. References

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