Effect of the Size and Carbides Dispersion in the Sintering and Hardness of Samples of Stainless Steel Reinforced with NbC And TaC

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Abstract

The present study investigates the behavior of the sintering and hardness of stainless steel samples reinforced with NbC and TaC. Matrixes of pure stainless steel were compacted with addition of up to 3% wt NbC or TaC in a cylindrical die of steel (∅ = 5,0 mm) at 700 MPa and sintered in an electrical resistance furnace under argon atmosphere. The sintered samples were characterized by density and hardness measurement, optical microscopy and scanning electron microscopy (SEM). The preliminary results show that the size and distribution of carbides influence in the sintering and hardness of the sintered samples.

Keywords : stainless steel, sintering, carbides, composites and hardness

1. Introduction

Metal matrix composites (MMC) appear to be promising option for wear applications. These materials combine a soft metallic matrix with hard ceramic particles that resist to the wear. The ceramic particles that can be used to reinforce MMC include carbides and oxides. Recently, the use of iron-based alloys or steels as the matrix materials for MMC has attracted considerable attention Fe-based alloys, particularly austenitic stainless steels, exhibit higher strength, stiffness, and ductility compared to aluminum. Furthermore, a wide range of mechanical properties combined with excellent corrosion resistance make stainless steels very versatile in their applicability. However, austenitic stainless steels have poor sinterability. Moreover, they have poor wear resistance due to their low hardness. The incorporation of carbide particles into stainless steel matrixes can lead to a dramatic improvement in their hardness and wear properties.

The present study investigates the behavior of the sintering and hardness of stainless steel samples reinforced with NbC and TaC. The samples were sintered in a dilatometer. The heating rate, sintering temperature and time used were 40°C/min, 1290ºC and 30 min respectively. The preliminary results show that the size and distribution of carbides influence in the sintering and hardness of the sintered samples.

2. Experimental and Results

Table 1. Results of hardness and density obtained for stainless steel samples with and without addition of carbides (3% wt) sintered at 1290ºC during 30 min (the numbers between parentheses to the side of the value of hardness are the number of measures for each sample).

Samples	Heating Rate ^{0}C/min	Density		Hardness	
		Sintered	Relative	Load (gf)	
		g/cm^3	(%)	500	1000
B16	40	7,61 ± 0,08	95,5	53,0 ± 8,0$^{(10)}$	56,0 ± 6,0$^{(10)}$
B17	40	7,58 ± 0,07	95,1	70,0 ± 14,0$^{(10)}$	58,0 ± 9,0$^{(10)}$
B18	40	7,60 ± 0,07	95,4	52,0 ± 6,0$^{(10)}$	53,0 ± 10,0$^{(10)}$
B19	40	7,64 ± 0,07	93,5	75,0 ± 14,0$^{(10)}$	71,0 ± 10,0$^{(10)}$
B20	40	7,59 ± 0,09	92,9	59,0 ± 10,0$^{(10)}$	62,0 ± 5,0$^{(10)}$
Obs: B16 = 316L; B17 = 316L + NbC (J. Matthey), B18 = 316L+ NbC (UFRN), B19 = 316L+ TaC (Sigma Aldrich) and B20 = 316L+ TaC (UFRN).					

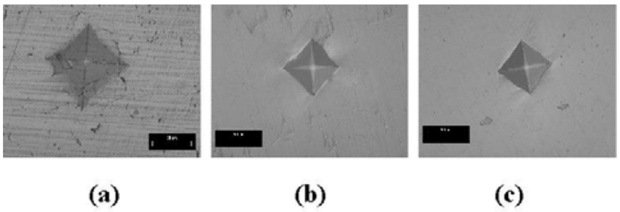

Fig. 1. Typical imagens of indentation obtained with a load of 500gf for sintered samples with relative density > 95: %: (a) B19 – sintered in the no dilatometer, (b) B18 e (c) B17 - sintered in the plasma furnace (bar size=50μm).

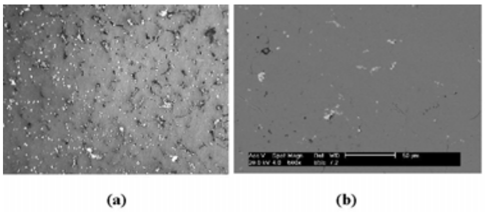

Fig. 2. Typical carbides distributions in the metalic matrix of stainless steel: (a) amostra B18 e (b) amostra B19.

It is fundamental in this point to consider our results in function of the relation between the carbides distribution in the boundary grain and the density and hardness values (table 1). It is known that the precipitation of these ceramic in the grain boundary it increase the restriction at the movement of the dislocations and can act as inhibitor of the growth of grain and modifier of the mechanical properties of the sintered material. Inside of this in the figure 2 note if that the carbides distribution in the microstructure of the sintered sample in plasma furnace (2a) is more uniform than the sintered in the dilatometer (2b). Associated to it was observed on previous works [4] that the uniform distribution of the carbides in the sintered samples in plasma furnace it influenced significantly in the densification and mechanical properties obtained (to compare figure 1a with 1b, 1c and figure 2a with 2b). This is, went possible to produce very homogeneous samples with a relative density between 97% and 100%, without exaggerated grain growth and highest hardness values (174 HV).

With base in the results obtained in plasma furnace is being developed at the moment a procedure to uniformize the size and carbides distribution in the starting mixture. Later samples will be sintered in the dilatometer and if wait to obtain parts with similar characteristics at sintered in the plasma furnace

3. Summary

-The production of samples with a relative density between 97% and 100%, without exaggerated grain growth and highest hardness values can be associated the obtaining of mixture of the starting powders of a reproductive form where carbides meet distributed uniformly in the metallic matrix.

- It is necessary to develop a procedure to dissolve the agglomerates and to uniform the size of particle of the starting carbides.

4. References

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