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doi:10.1017/S1431927622010571
Microsc. Microanal. 28 (Suppl 1), 2022

Effect of Sintering Temperature in Tungsten Carbides Bonded with High and Medium Entropy Alloys.

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Cemented carbides are composed of a hard phase (WC) and a binder phase (Co); most cutting tools are made of this material since to possess high mechanical properties of hardness, abrasion resistance, and toughness [1]. The function of the binder is to provide a liquid phase to join the hard carbide particles in the sintering process and achieve greater densification of the material; an amount of around 20 and 10% by weight is usually used [1]. The use of medium and high entropy alloys as a substitute for cobalt is mainly based in that they can form stable solid solutions due to the enthalpy values they present [2]. Cemented carbide cutting tools are usually produced through conventional powder metallurgy. In this sense, the temperature used in sintering is an important parameter to consider because greater densification in the material can be achieved, improving the system's mechanical properties [2]. Thus, this work evaluates the microstructure, densification, and microhardness incorporate medium and high alloys entropy as substitutes for cobalt in cemented carbides.

The CoCrFeMnNi (HEA) and CoCrNi (MEA) alloys were synthesized by mechanical alloying (MA). The elemental powders were taken with a purity of 99.99%, and the milling time was 10 h in a high-energy mill Spex 8000. Subsequently, the milling time of WC-MEA and WC-HEA compounds was 2h, with a variation of the composition of 80, 85, 90, and 95% WC (wt. %). The compaction of the powders was carried out using a hydraulic press under a compaction pressure of 1.56 GPa for 5 min. The sintering process was performed at 1300 and 1400 ºC for 1, 3, and 5h in vacuum-sealed quartz ampoules. The microstructural characterization was carried out by a scanning electron microscope HITACHI SU3500, and Vickers microhardness was evaluated in LM300 AT tester. Finally, the density of the samples was calculated using the Archimedes method in analytical balance Sartorius CP2250.

Figures 1 and 2 shows micrographs obtained by SEM-SE, and Figure 3 presents the results of densification and microhardness; it is observed that increasing the sintering time and temperature reduces the porosity and increase in densification and microhardness in the systems. In the sintered samples at 1400ºC, more significant densification is observed mainly in the compounds with a higher concentration of high and medium entropy alloys. The microhardness in the material is maintained with higher values in the percentages with a greater amount of WC. It is concluded that the addition of alloys of high and medium entropy reduces the hardness of the material, and greater ductility is likely to be achieved. Finally, the comparison of sintering temperatures concludes that the values of densification and microhardness at 1400° C are higher than at 1300° C.

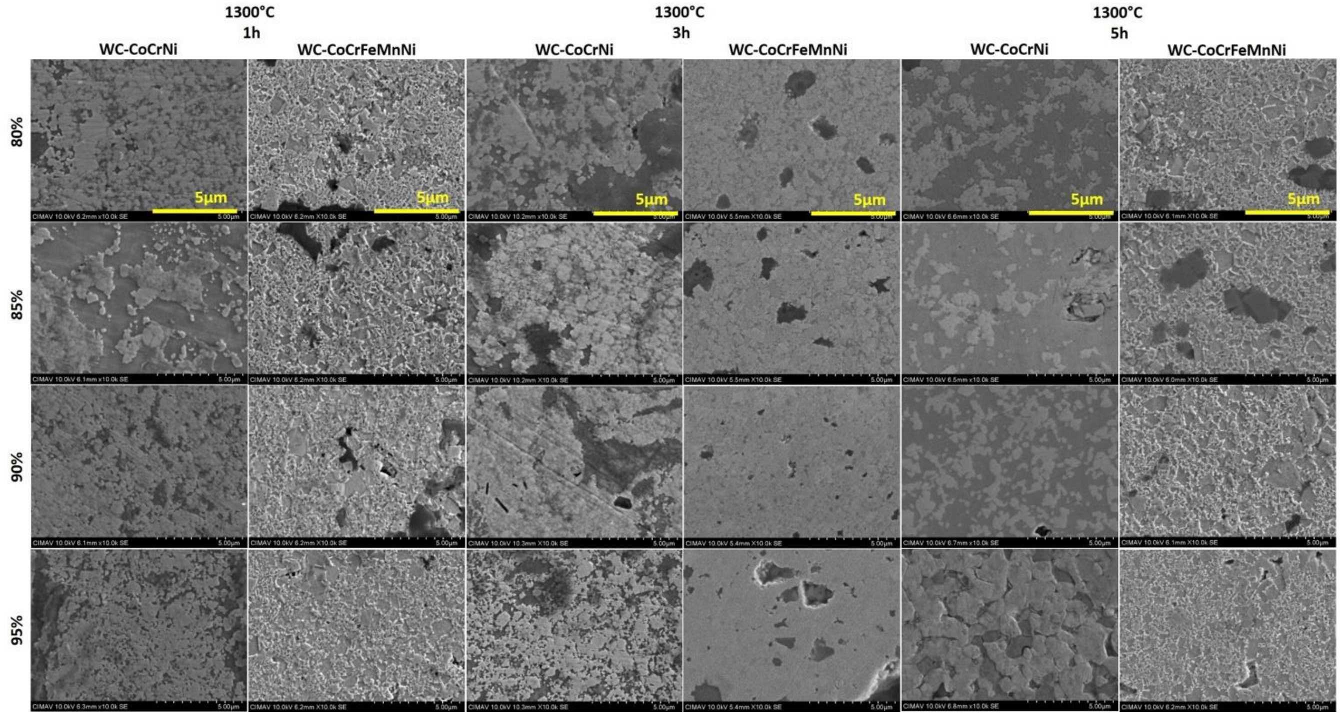

Figure 1. SEM-SE micrographs of the samples sintered at 1300°C for 1, 3, and 5 h.

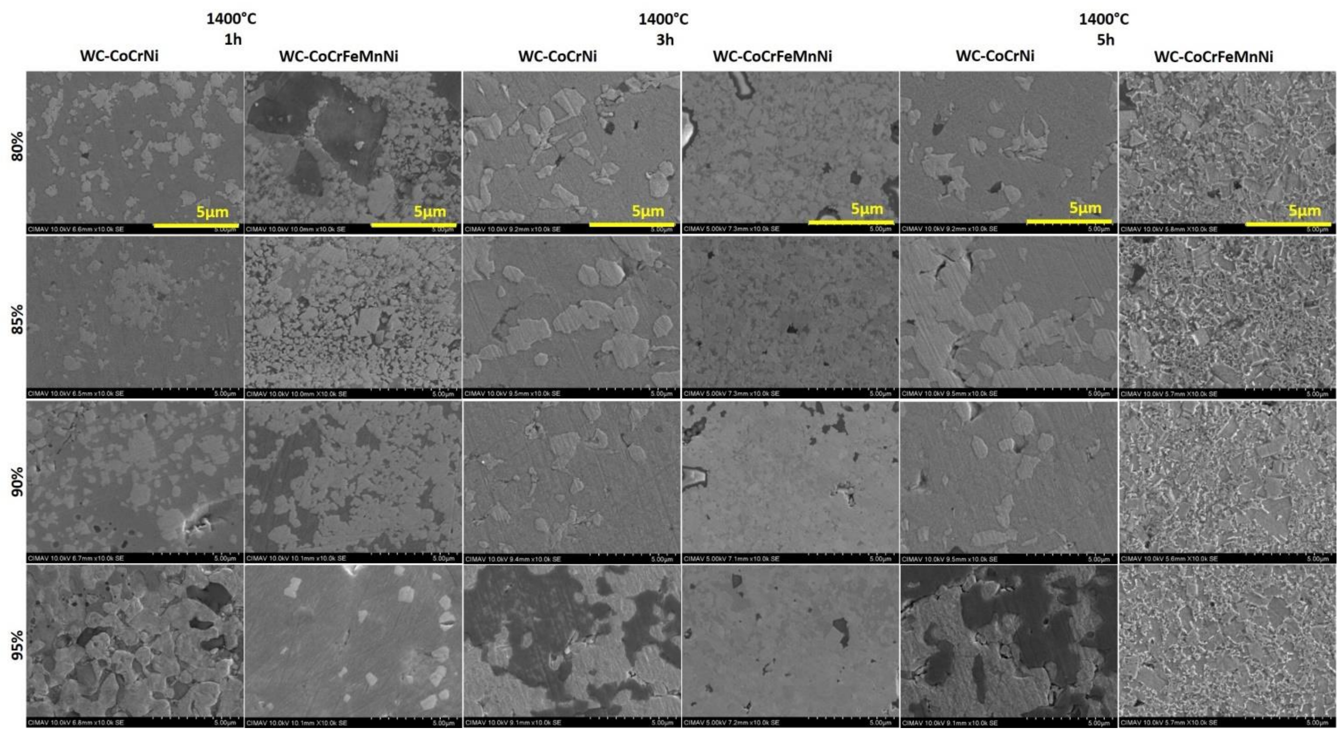

Figure 2. SEM-SE micrographs of the samples sintered at 1400°C for 1, 3, and 5 h.

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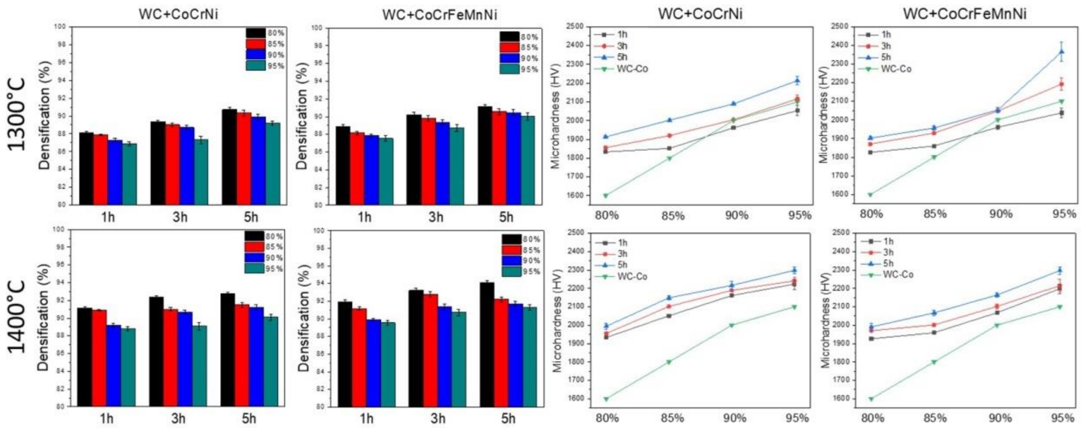

Figure 3. Values of densification and microhardness obtained from the WC-CoCrNi and WC-CoCrFeMnNi systems sintered at 1300 and 1400°C.

References:

[1] Lining G, Jiwu H, & Chen X, Effects of carbon content on microstructure and properties of WC–20Co cemented carbides, (2014), International Journal of Refractory Metals and Hard Materials, Volume 42, p. 228-232.

[2] Jialin Sun, Jun Zhao, Feng Gong, Xiuying Ni & Zuoli LiZ, Development and Application of WC-Based Alloys Bonded with Alternative Binder Phase, (2019), Critical Reviews in Solid State and Materials Sciences,Volume 44:3, p. 211-238.

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