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# Influence of Co Addition to Fe-Cu Alloys

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**Abstract** – Fe-Cu-Co alloys are the new generation of metal matrix for diamonds in powder metallurgy processed cutting tools. In this work, samples of Fe-(30-45-60)wt%Cu and Fe-60%wtCu-(10-20-30)wt%Co alloys were processed by cold pressing at 350MPa, followed by sintering at 1150ºC/25min./$10^{-2}$mbar. Structures formed during sintering were studied by XRD and EDS. Microstructural aspects were observed by SEM. Densification, hardness, compressive strength and wear tests were also performed. Increased Cu content promoted gain in mechanical properties of Fe-Cu alloys. The alloy Fe-60%wtCu-30%wtCo presented the best global results.

Fig.1a shows the densification and Rockwell B hardness of the sintered samples. One can observe that no significant gain in density (RD) was observed for Fe-Cu samples, with increasing Cu content. In the other hand, It is clear that Co content plays an important role on the densification of the Fe-Cu alloys, as predicted by Barbosa [1]. In the point of view of hardness, one can observe that Cu additions improve sligthly this property – just because the sintering condition promotes an extensive liquid phase, where Cu percolates the Fe particles much more efficiently – similar effect was studied by Oliveira et al [2]. In this case, 60wt%Cu was taken as the ideal copper content, and it was proved elsewhere [3]. Co effect on Fe-Cu hardness is straightforward. As seen, there occurs an sensible gain in hardness for increasing amount of Co. It is atributed to the Fe-Co solid solution formation during sintering, as explained afterwards. Values of hardness are compatible with the current literature [1-4].

Fig.1b presents results of compressive tests – yield strength, and wear resistance of Fe-Cu-Co sintered samples. It is observed that an almost linear behavior of the $\sigma_Y$ took place, thus indicating that the governing phenomena of strengthening is, probably, due to the Fe-Co solid solution, regardless of the microstructural features, such as porosity. Regarding the wear resistance, similar behavior may be seen, except for 30wt%Co addition. The last composition experiences an abnormal gain in wear resistance, which is, again, atributed to the extensive Fe-Co solid solution formation, what strengthens the alloy. It explains why the comercial Fe-Cu-Co alloys presents Co content ranging from 20 to 30wt%.

XRD pattern related to the Fe-60wt%Cu-20wt%Co alloy showed extensive Fe-Co formation, what explains the aforementioned mechanical properties results. Microstructure of this same alloy is shown in fig.1c, and its aspect is of an eutectoid reaction, as predicted in refs.[1,4-5]. Typical residual porosity is present, due to the relations between the Fe-Cu solubilities at the sintering temperature, what promotes swelling, instead of complete densification – see fig.1a. In this micrograph one can obseve the points A and B, where EDS pontual chemical analyses were performed. The darker region is comprised of only Fe. Point A is regarded to a Cu matrix embbeding a Fe-Cu solid solution. The proportion of Fe-Co in point A is 1:3, thus indicating that practically all Co is in this solid solution, once B is pure Fe. This result is in fair agreement with the XRD spectra.

Results show the importance of using high Cu content in the Fe-Cu-Co alloys. Other aspect is that Co improves substantialy the properties of the Fe-Cu alloys.

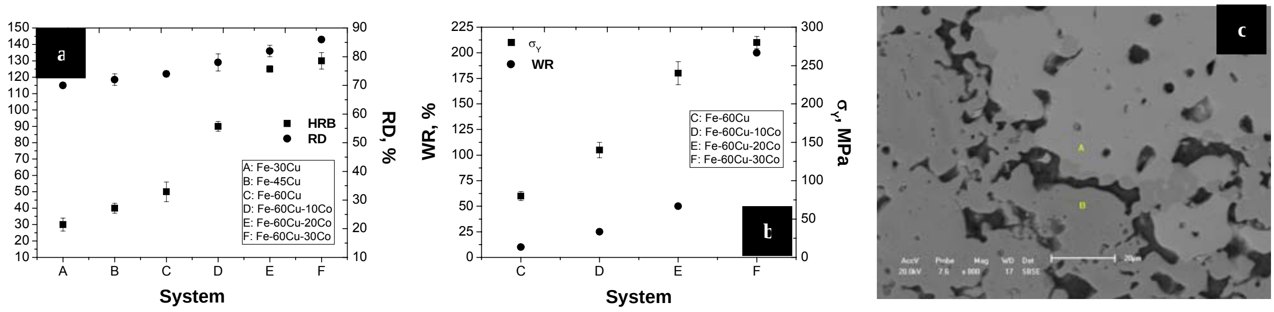


**Figure 1:** (a) hardness and densification behavior of Fe-Cu and Fe-Cu-Co alloys; (b) wear resistance and yield strength of the Fe-Cu-Co alloys; (c) microstructure of the Fe-60wt%Cu-20wt%Co alloy.

## References

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