

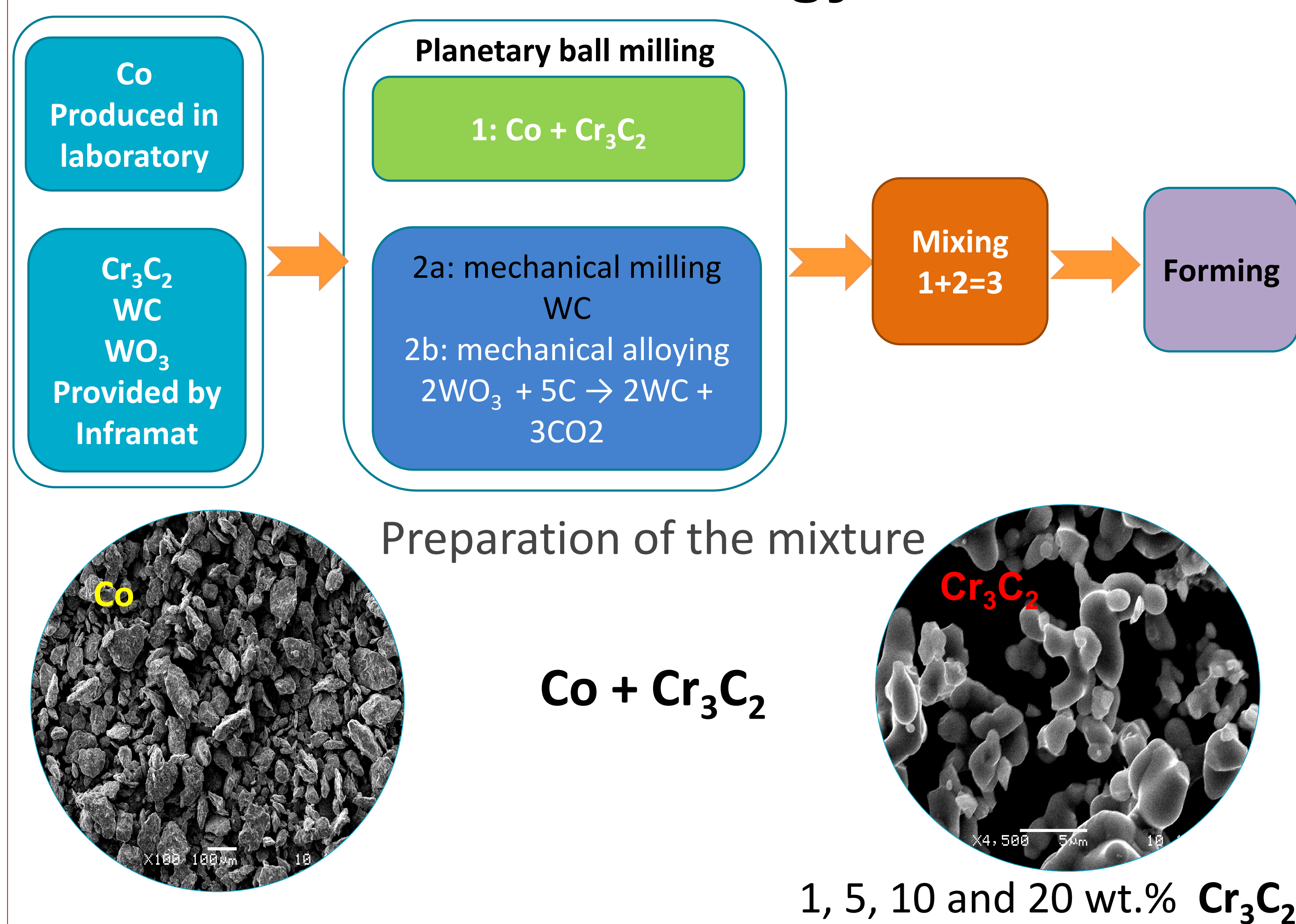


Cobalt-inhibitors mixtures for cemented carbides

Abstract

In cemented carbides based on ultrafine carbide powders, the use of growth inhibitors is indispensable for the preservation of satisfactory mechanical properties of sintered product. The inhibitors manifest their effect by blocking tungsten carbide diffusion through the metal binder. Use of chromium carbide as inhibitor has proved very effective, especially by ensuring a high toughness for the alloys where it is used. According to recent studies that have proved that the diffusion distance is very important in effective inhibition of carbide particles growth, there are limits which should not be exceeded. An homogeneous distribution and a lower inhibitor particle size are the premises to obtain a uniform microstructure. This study was aimed at obtaining homogeneous carbide-binder-inhibitor mixtures. To this end, four (4) Co + inhibitor compositions have been milled in a planetary mill under dry and wet conditions. Grinding effect on the homogeneity of the powder was studied by X-rays diffraction, optical and electron microscopy on polished samples. Subsequently, the optimal mixture will be mixed with nano tungsten carbide and sintered to verify effectiveness.

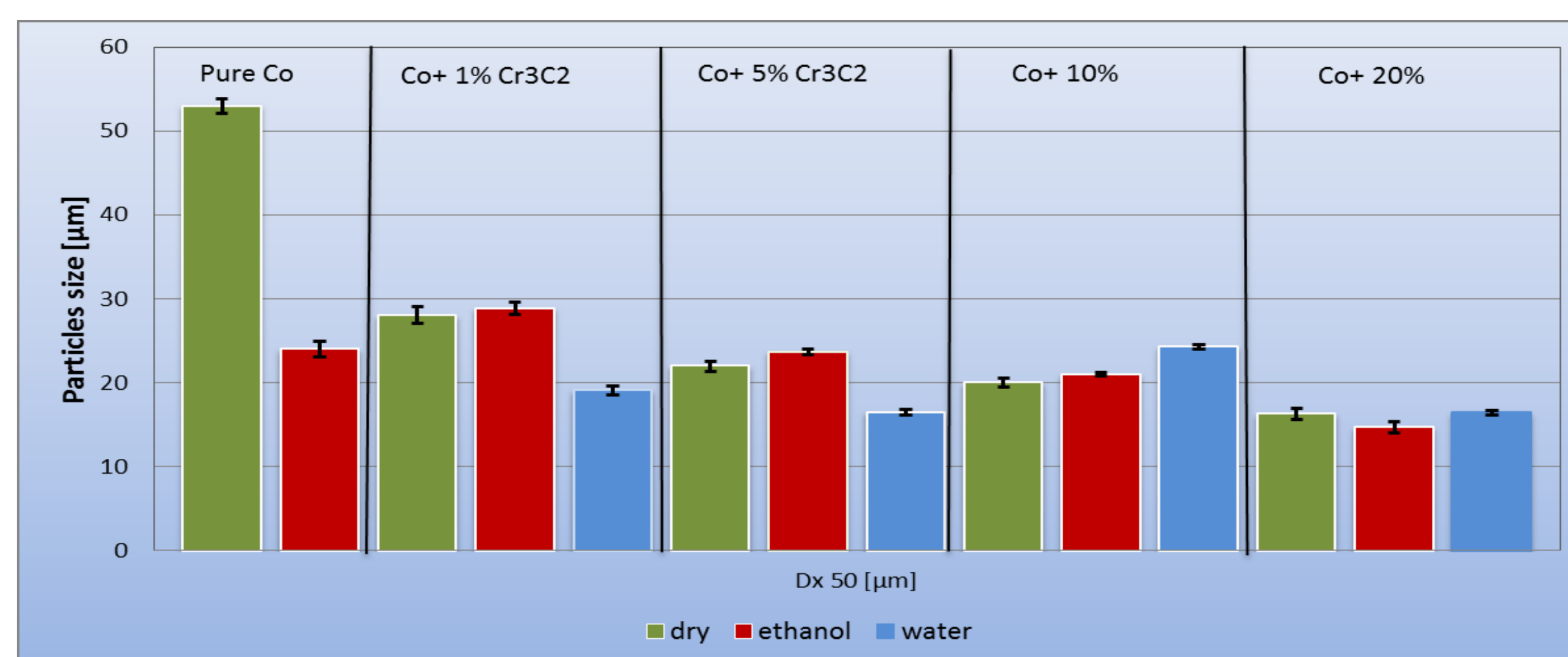
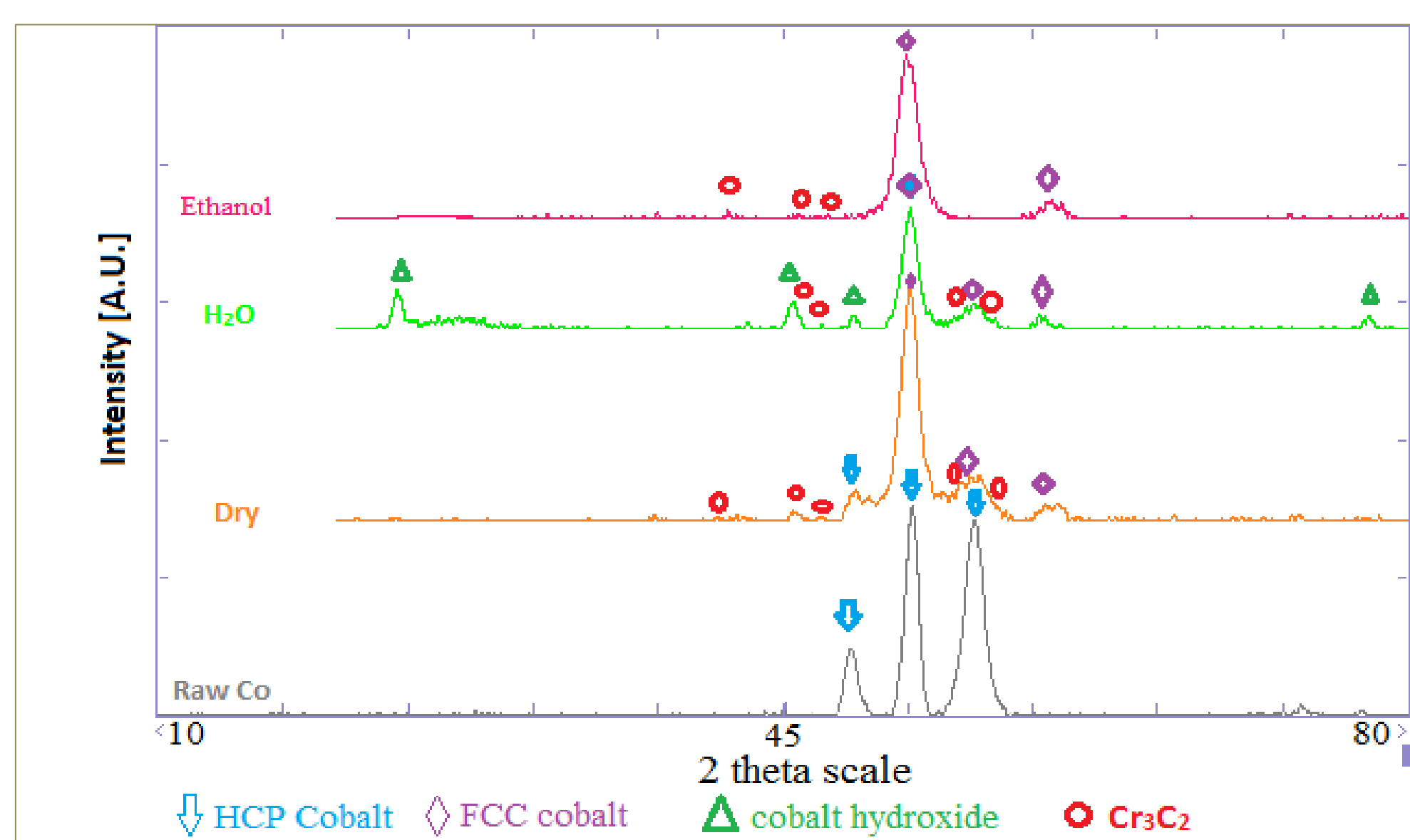
Methodology



Planetary mill Pulverisette 7 Premium line



XRD patterns for mixtures of cobalt +10% Cr₃C₂ after 10 hours of milling



Cobalt crystallites size for the powders milled for 10 hours

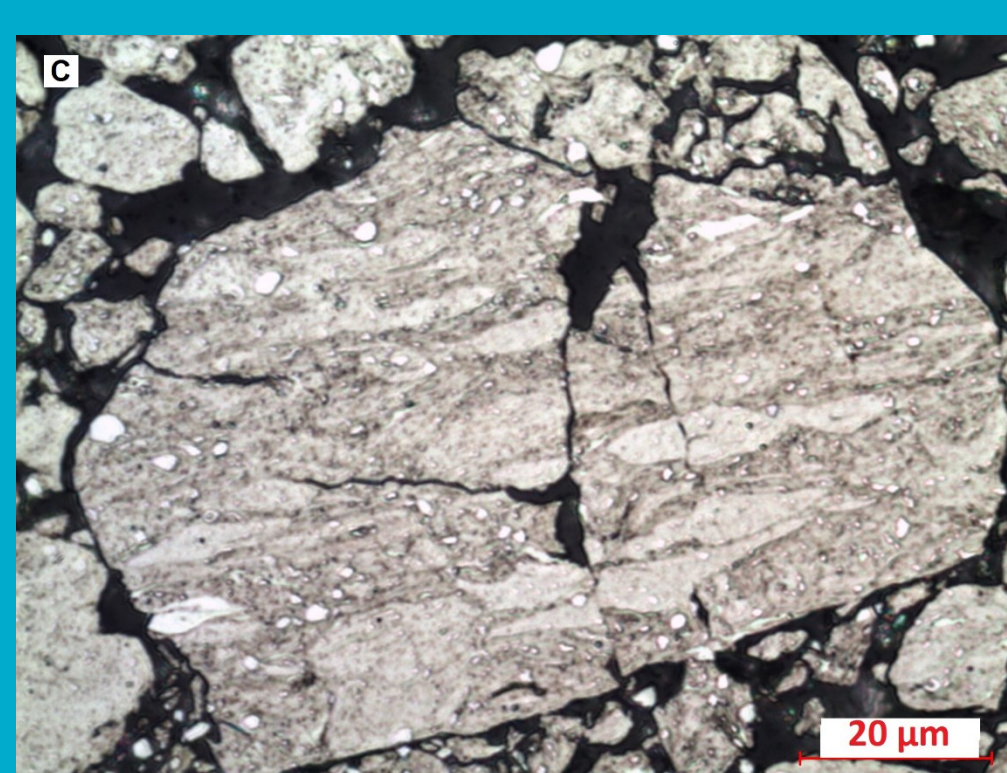
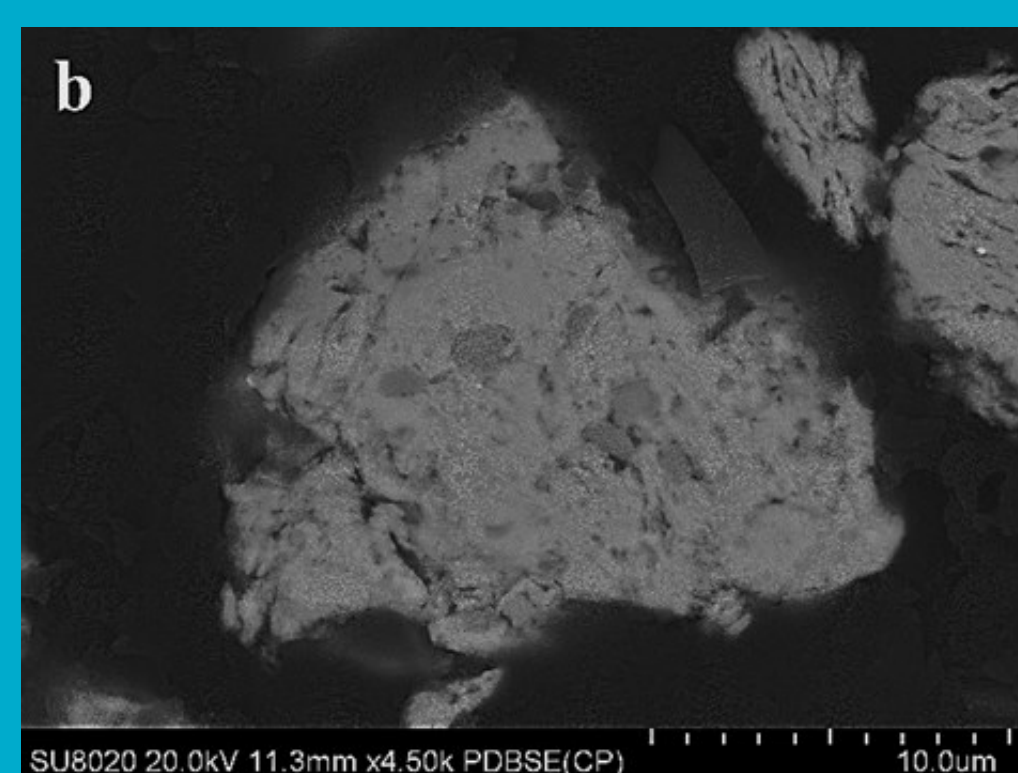
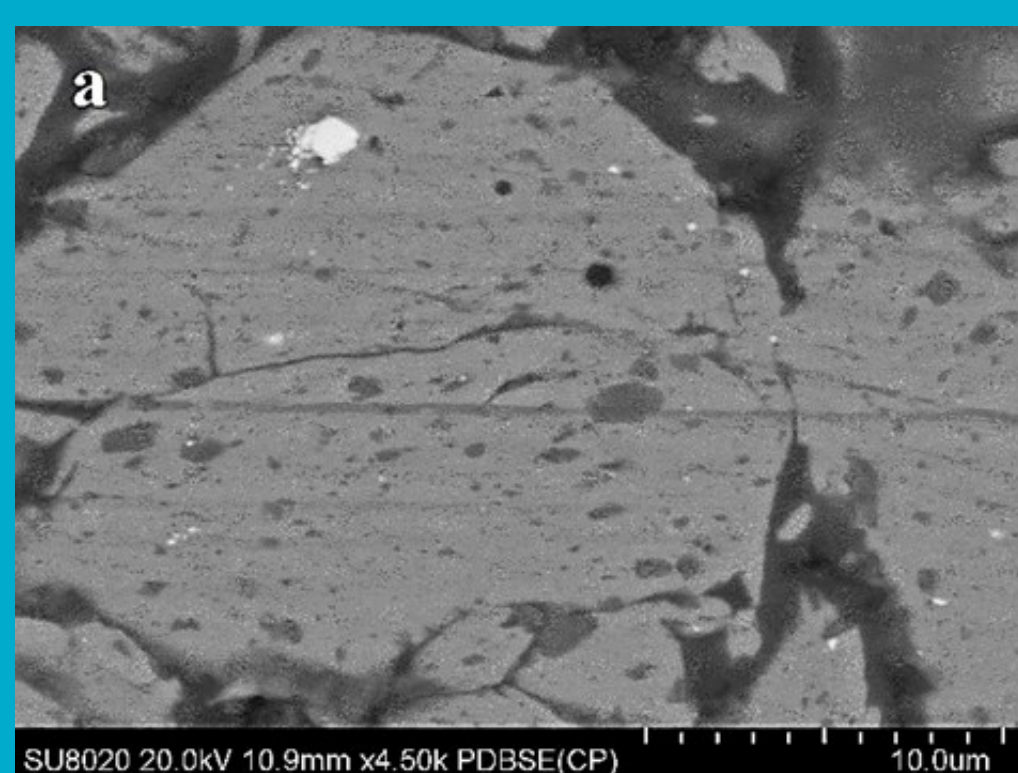
Milling conditions	Inhibitor Cr ₃ C ₂ content[% by weight]			
	1	5	10	20
Dry	70% HC = 131 nm 30% FCC = 67 nm	12% HC = 157 nm 88% FCC = 12 nm	9% HC = 400 nm 91% FCC = 39 nm	5% HC = 312 nm 95% FCC = 34 nm
H ₂ O	100% HC = 132 nm	75% HC = 119 nm 25% FCC = 66 nm	1% HC = 200 nm 99% FCC = 7.5 nm	100% FCC = 6.3 nm
Ethanol	80% HC = 113 nm 20% FCC = 120 nm	60% HC = 113 nm 40% FCC = 94 nm	3% HC = 110 nm 97% FCC = 5.4 nm	1% HC = 59 nm 99% FCC = 4.3 nm

Conclusions

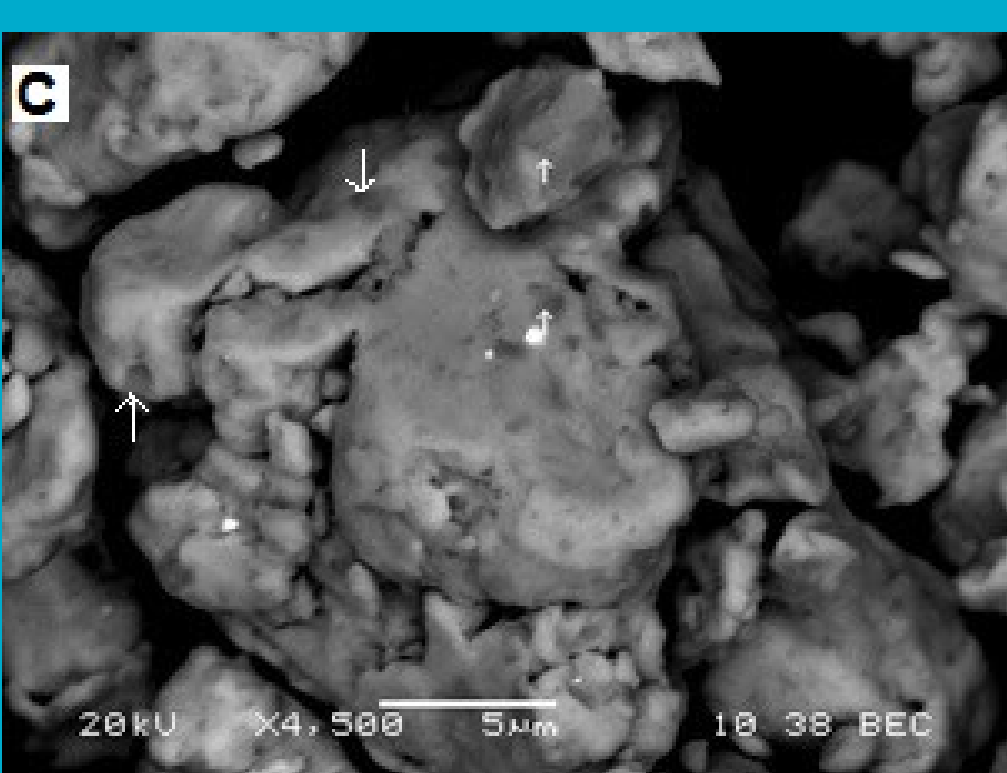
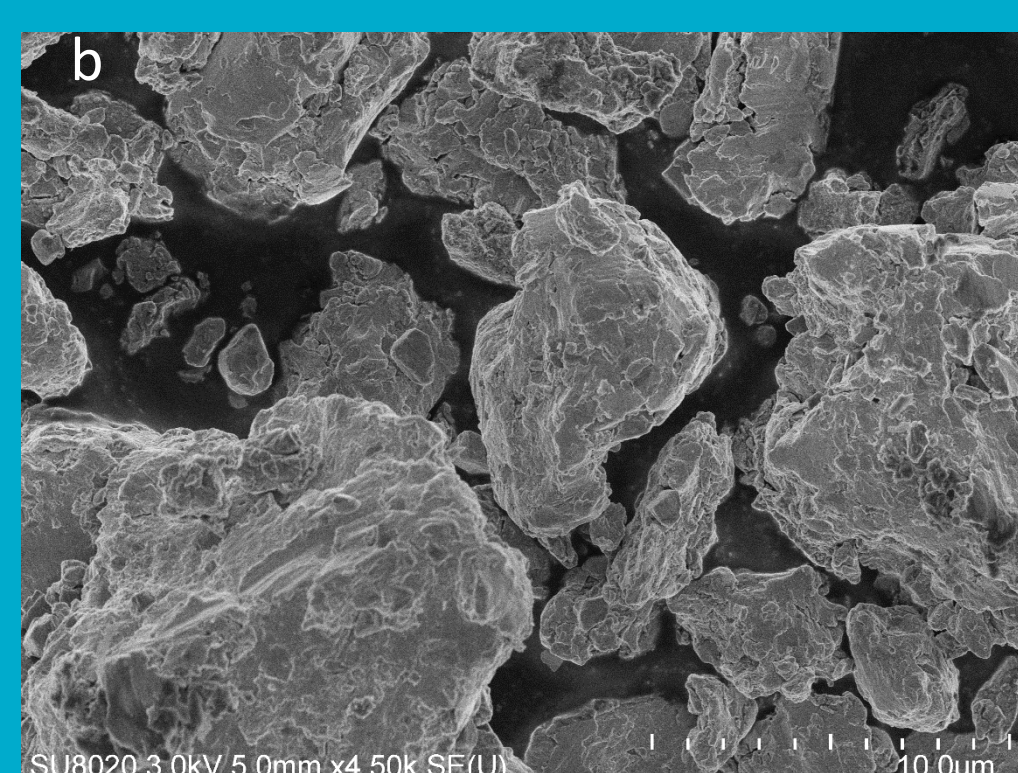
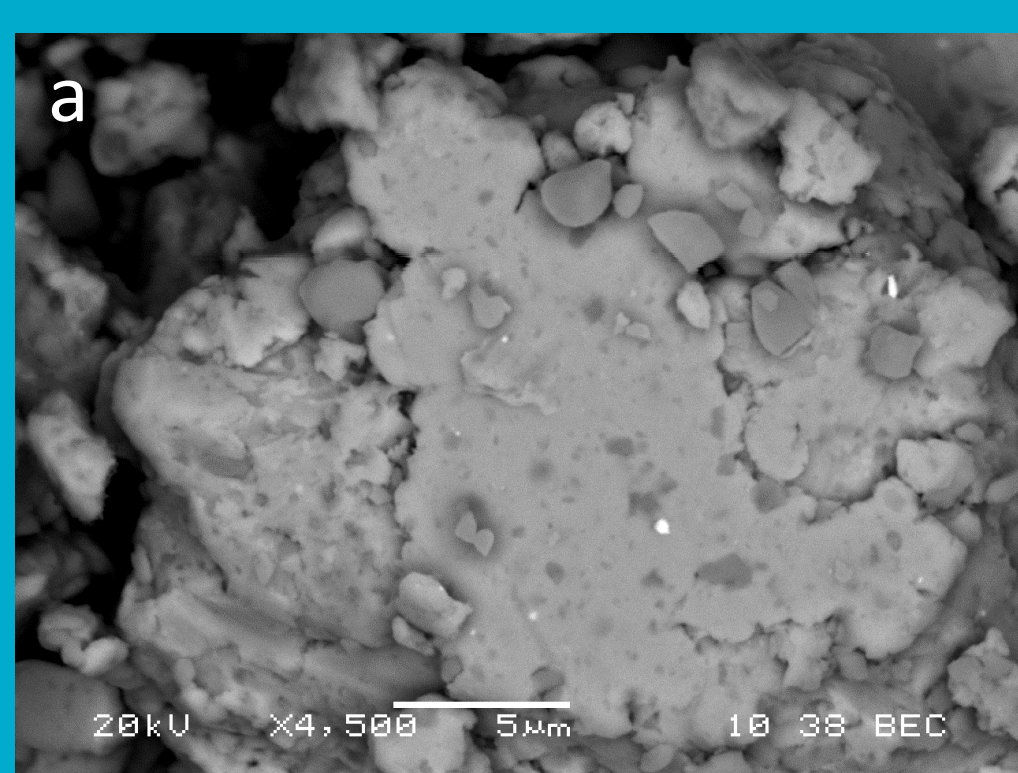
- As the size distribution depends on the milling media and the composition of the mixtures, the use of liquid milling reduces the grain size.
- The degree of oxidation of the cobalt in water milled powder is considerable and cobalt hydroxide particles are formed. Water is thus not the most recommended grinding medium.
- The use of ethanol as a liquid milling medium allows obtaining a particle size of the powder similar to that obtained with water without oxidation of the cobalt powder.
- In terms of crystallite size, in dry milling conditions, a decrease in size with chromium carbide content was observed, from 130 nm at 1 wt.% Cr₃C₂ to 34 nm at 20 wt.% Cr₃C₂.
- A transition from HC cobalt to FCC was observed, going from 70 vol.% HC for Co -1 wt.% Cr₃C₂ to only 5 vol.% HC for an alloy with 20 wt.% Cr₃C₂. This transformation is more evident in liquid medium. At low concentrations of chromium carbide, HC to FCC conversion is smaller than for dry grinding, however this transformation approaches 100% at high chromium carbide concentrations.

Bibliography

V.I. Stanciu, V. Vitry, F. Delaunois, Proceedings 23rd International Conference on Metallurgy and Materials METAL 2014, Brno, Czech Republic, 21 - 23 Mai 2014.



Co+5% Cr₃C₂ powder microstructure after 10 hours of milling: a) in water b) in ethanol and c) dry. SEM 4500X.



Co+5% Cr₃C₂ powder morphology after 10 hours of milling: a) in water b) in ethanol and c) dry. SEM 4500X.

Contact

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