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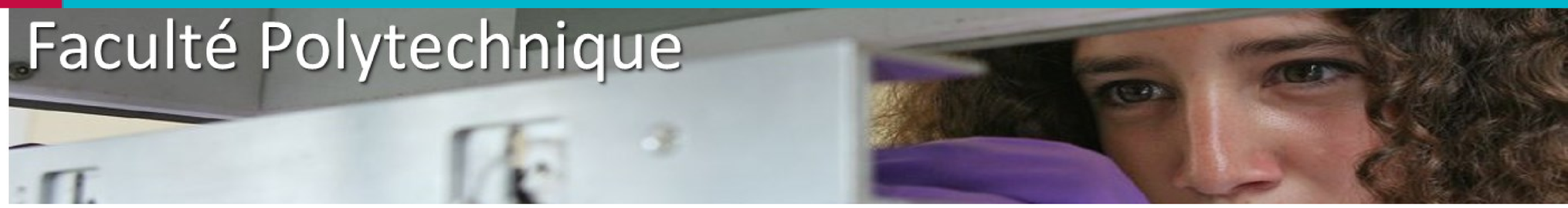


Nanostructured mix of tungsten carbide with cobalt for wear parts

Keywords: Nano tungsten carbide, cobalt, mechanical alloying, homogenization

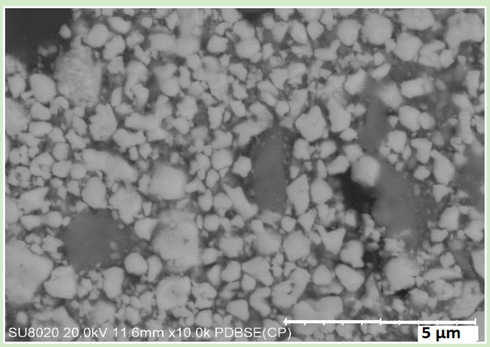
Abstract

Cobalt-tungsten carbide (WC-Co) composites are extensively used to manufacture wear-resistant tools. The mechanical properties of these composites are closely related to the particle size of tungsten carbide and to the thickness of the cobalt layers that link them. It is currently possible to produce nano-tungsten carbide powders by several methods. However, given the large gap between the production time of the powder and the final processing, major agglomeration is observed.

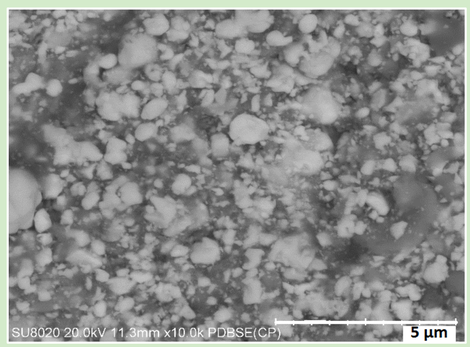
High energy grinding mills allow adjustment of mixing conditions by modifying the speed, number and size of balls, which leads to a wide range in the impact energy and the number of impacts.

This paper studies the problem of obtaining carbide particles uniformly coated with a layer of cobalt. Nano grained WC powder was prepared in the laboratory by grinding mixtures of WC + 10% Co in a planetary mill. The resultant powders were analyzed by electron microscopy, laser particles size and X-ray diffraction.

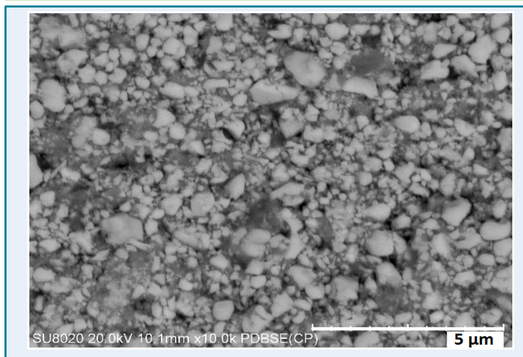
Tungsten carbide powder having a particles size of about 1 µm (378 nm grain size), was used.
The cobalt powder was mixed with 10% (by weight) of chromium carbide (Cr_3C_2) and milled for 10 hours.



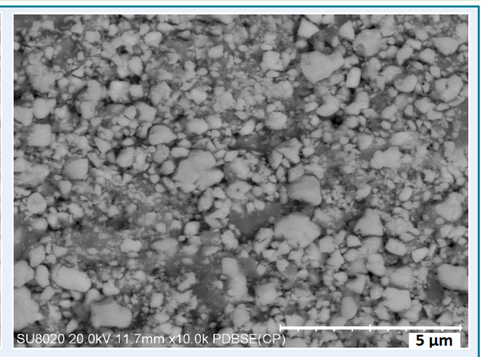
Powder milled 10 hours at 300 rpm with 10 mm balls.
SEM 10000X



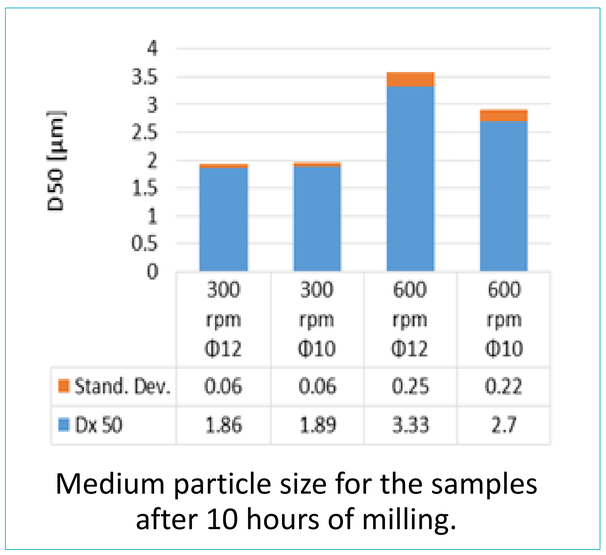
Powder milled 10 hours at 300 rpm with 12 mm balls.
SEM 10000X



Powder milled 10 hours at 600 rpm with 10 mm balls.
SEM 10000X

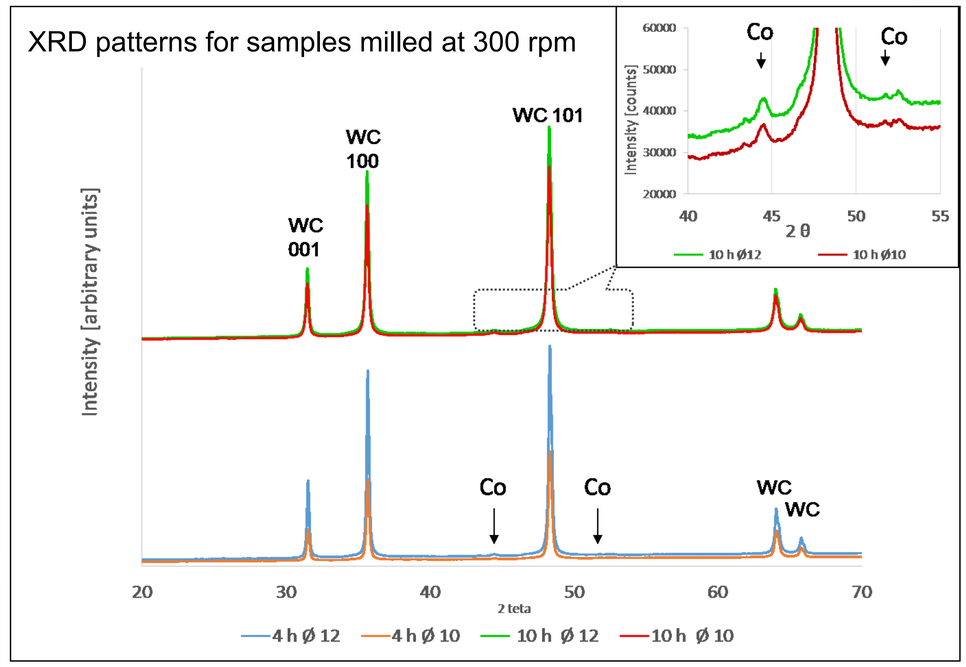


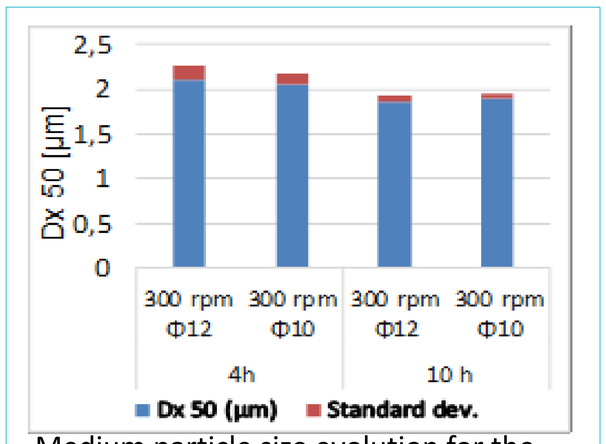
Powder milled 10 hours at 600 rpm with 12 mm balls.
SEM 10000X



	300 rpm Φ12	300 rpm Φ10	600 rpm Φ12	600 rpm Φ10
Stand. Dev.	0.06	0.06	0.25	0.22
Dx 50	1.86	1.89	3.33	2.7

Medium particle size for the samples after 10 hours of milling.



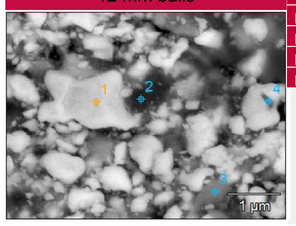


Medium particle size evolution for the samples milled with 300 rpm

Tungsten carbide crystallites size measured by XRD.

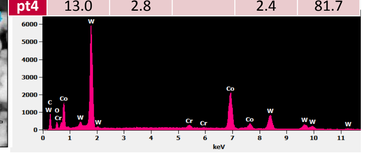
Samples, after 10 hours of milling	300 rpm, Ø10	300 rpm, Ø 12	600 rpm, Ø 10	600 rpm, Ø 12
Grain size [nm]	**303**	**280**	**181**	**177**

sample milled at 300 rpm
12 mm balls

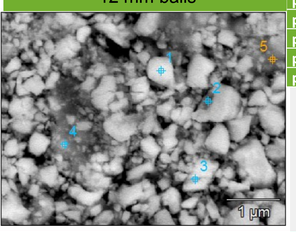


Chemical composition for the points localized on the sample milled at 300 rpm 12 mm balls. [wt %]

	C	O	Cr	Co	W
pt1	10.9	1.7		1.9	85.5
pt2	27.2	4.6		3.0	65.2
pt3	9.5	6.3	1.4	29.7	53.1
pt4	13.0	2.8		2.4	81.7

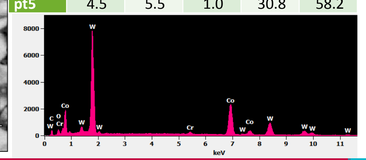


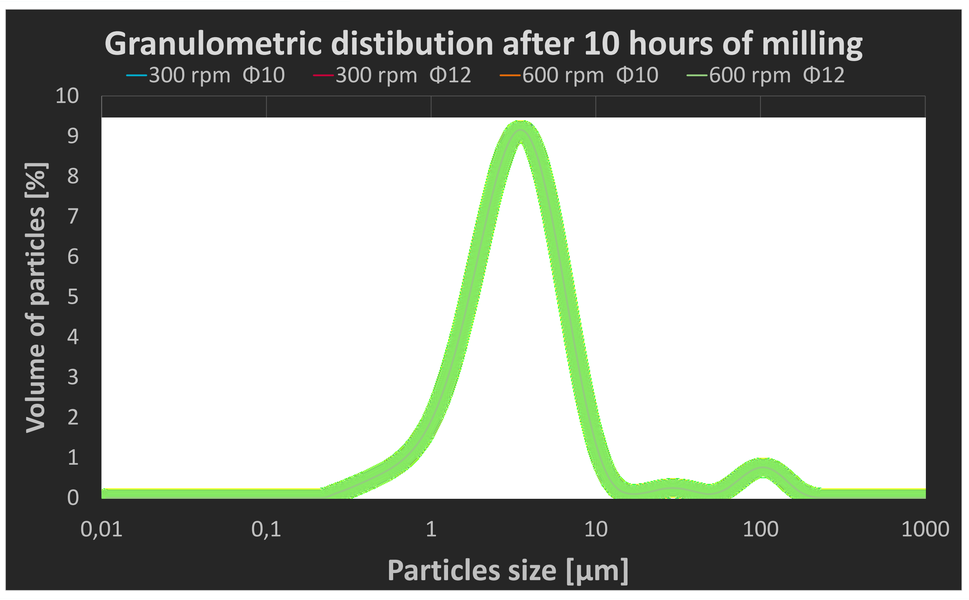
sample milled at 600 rpm
12 mm balls



Chemical composition for the points localized on the sample milled at 600 rpm 12 mm balls. [wt %]

	C	O	Cr	Co	W
pt1	3.0	1.7	0.3	3.6	91.3
pt2	7.0	2.7	0.4	3.2	86.6
pt3	3.1	1.8		3.5	91.6
pt4	5.9	6.8	0.5	21.0	65.8
pt5	4.5	5.5	1.0	30.8	58.2





Summary / Conclusion

- The presence of cobalt diminishes the grinding effect on the hard particles;
- We find that at low speed, results are similar for both sizes of balls;
- At high speed, the situation is different: we obtain finer particles but more agglomeration of the powder;
- The peak intensity of cobalt depends on the weight of grinding balls and of milling speed;
- A WC crystallite size of about 180 nm is obtained after 10 hours of grinding at a speed of 600 rpm.

Acknowledgements and Contact

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