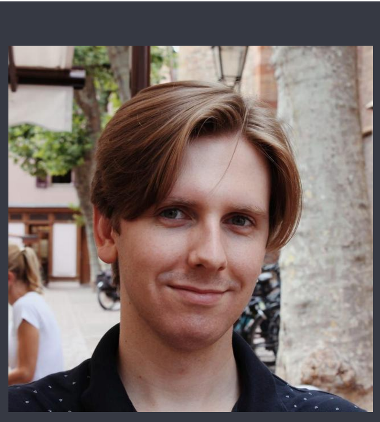

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A study on the milling process of carbon-doped FeMn-based binders for tungsten carbide

Context

The use of cobalt as a binder in tungsten carbide (WC) increasingly raises environmental, health, and ethical concerns. FeMn-based alternatives show promise, but eta-phase formation degrades the mechanical performance of WC - FeMn composites. Although carbon-doping can mitigate this, microstructural homogeneity remains insufficient.

Objectives

Aim of this study: Determination of the effect of a second milling cycle on the microstructure and properties of carbon-doped WC - FeMn composites.

Process adaptation: This second milling cycle mixes the elements making up the alternative binder with the carbon, before actually mixing them with the WC.

Compositions: WC - 10Co, WC - 8Fe2Mn and WC - 8Fe2Mn + C.

Materials & methods

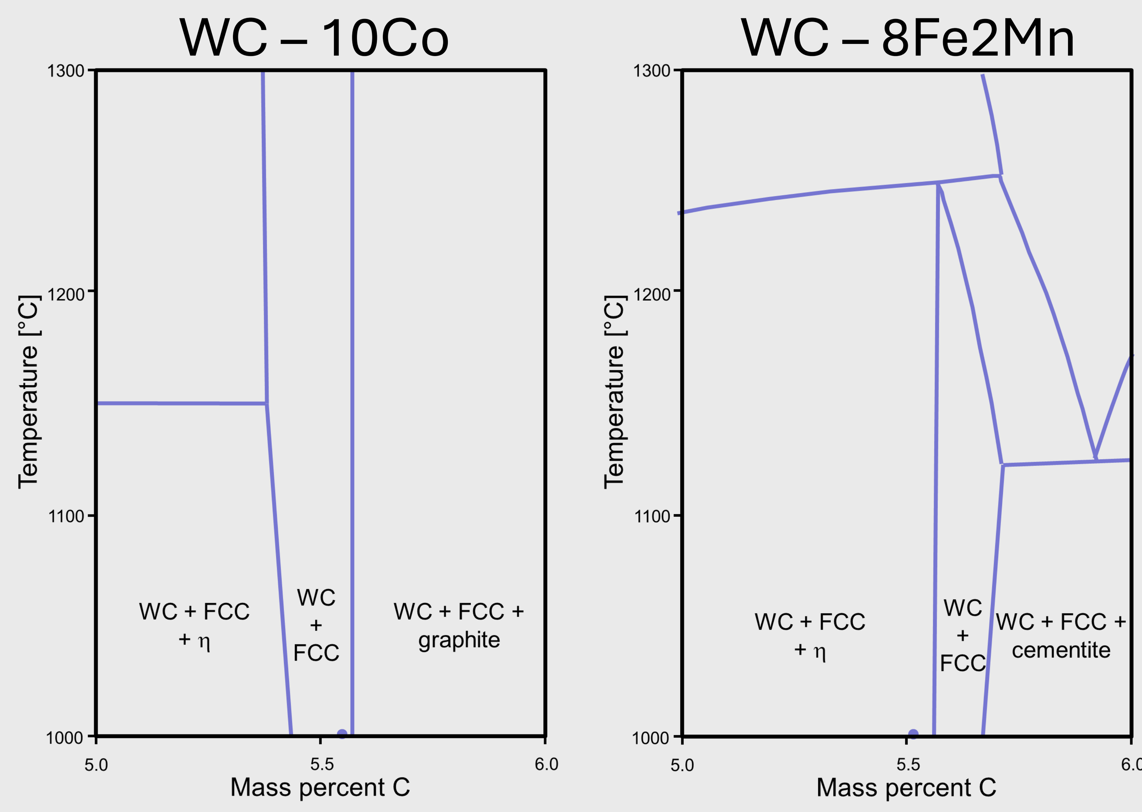
Processing: Powder metallurgy
Two milling cycles will take place in a planetary mill:

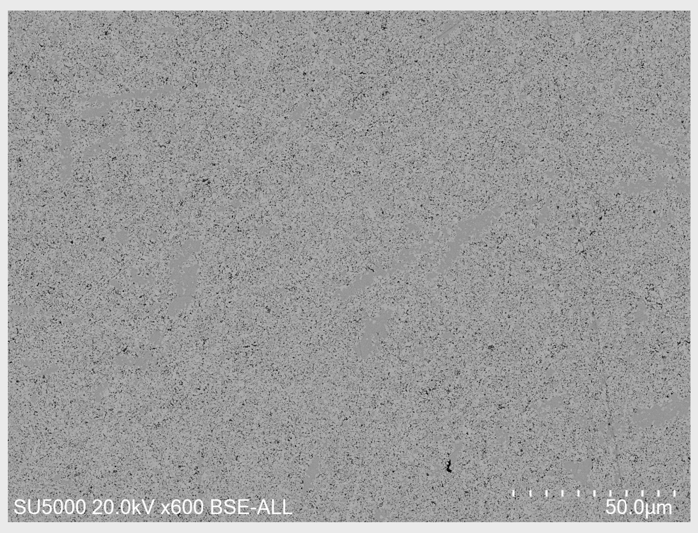
- The first will mix the Fe, Mn and carbon powders.
- The second will then mix the resulting doped binder with the WC powder.

Sintering: Vacuum sintering (1h, 1400°C, Ar atmosphere).

Samples characterization: porosity rate and densification determinations. SEM analysis, hardness (HV_{30}) and indentation fracture toughness (K_{IC}) with Palmqvist measurements.

Results

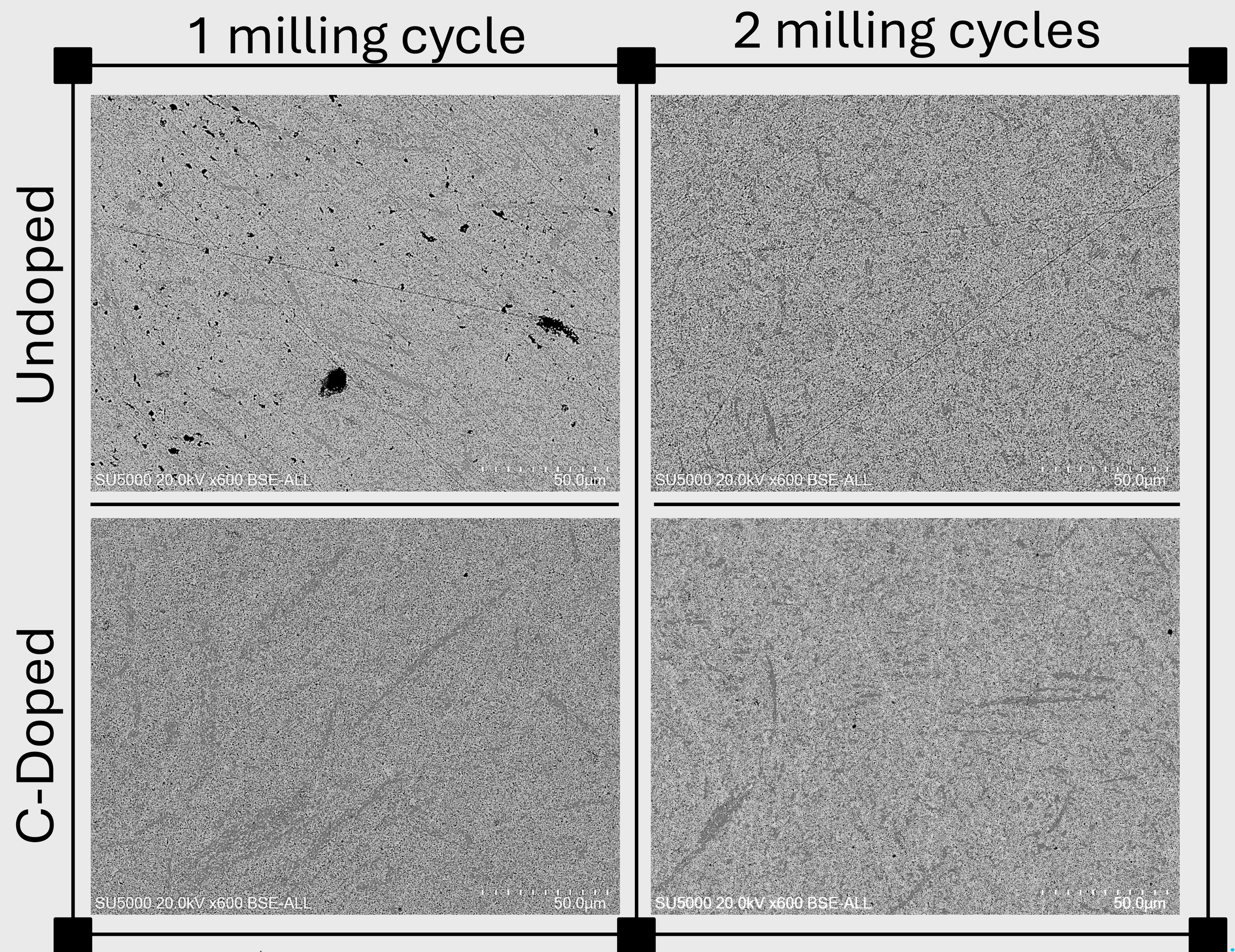




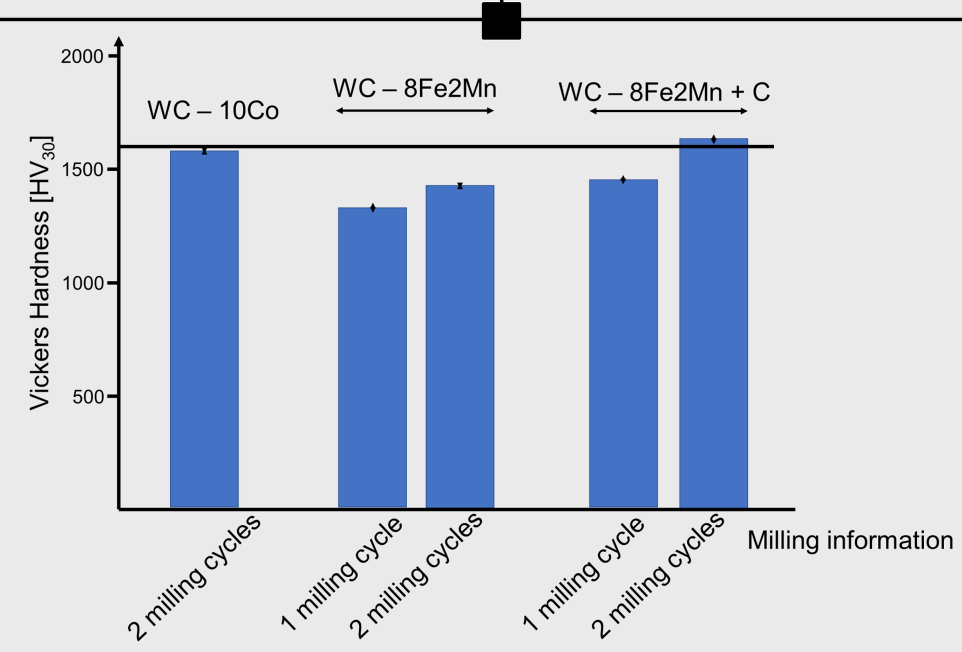
WC – 10Co

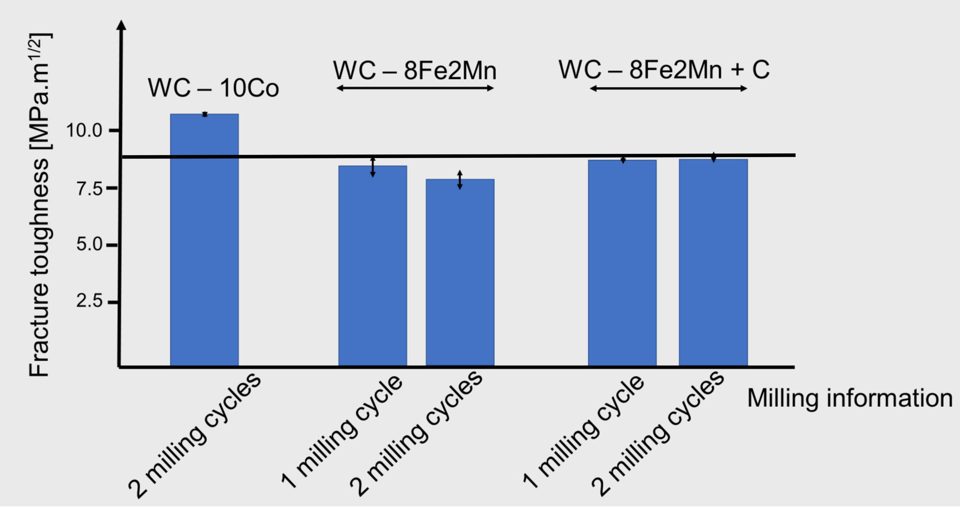
Densification = 99.9 ± 2.4 %

WC – 8Fe2Mn



Sample composition	Relative density
WC - 8Fe2Mn[1]	*90.2 ± 3.1 %*
WC – 8Fe2Mn + C[1]	*92.7 ± 2.6 %*
WC - 8Fe2Mn[2]	*92.4 ± 2.7 %*
WC - 8Fe2Mn+C[2]	*83.8 ± 2.2 %*





Conclusions & perspectives

- WC – 8Fe2Mn samples processed with two distinct milling cycles present a more homogeneous microstructure.
- Those samples also show better densification and increased mechanical properties. η-phase distribution among the microstructure is also more satisfactory.
- C-doping of the Fe-Mn binder decreases η-phase generation during sintering and also increases mechanical properties and densification.
- **Main perspective:** Future investigations will further characterize these samples, particularly in terms of corrosion and wear resistance.

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