Green alternative binders for tungsten carbide

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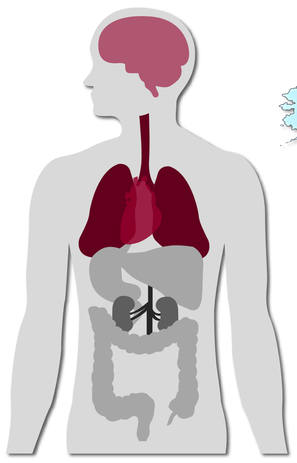
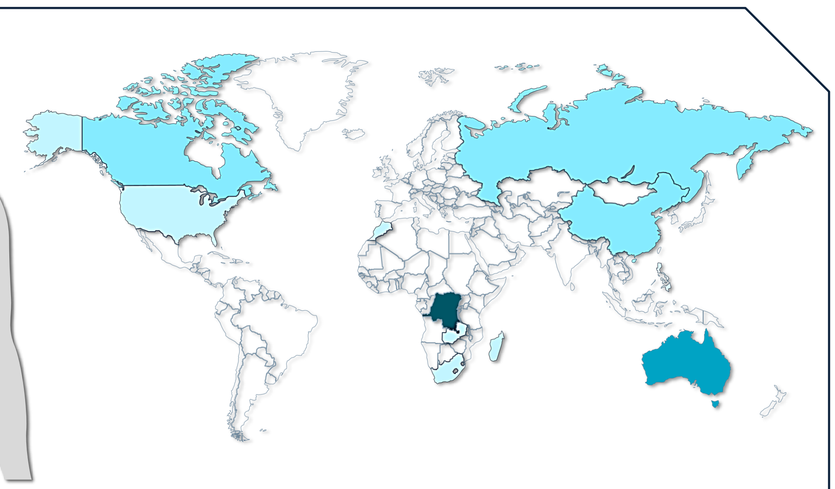
Context

Tungsten carbide (WC):
- » one of the best combination of hardness and toughness
- » requires the use of a binder phase to ensure the cohesion of the carbide grains

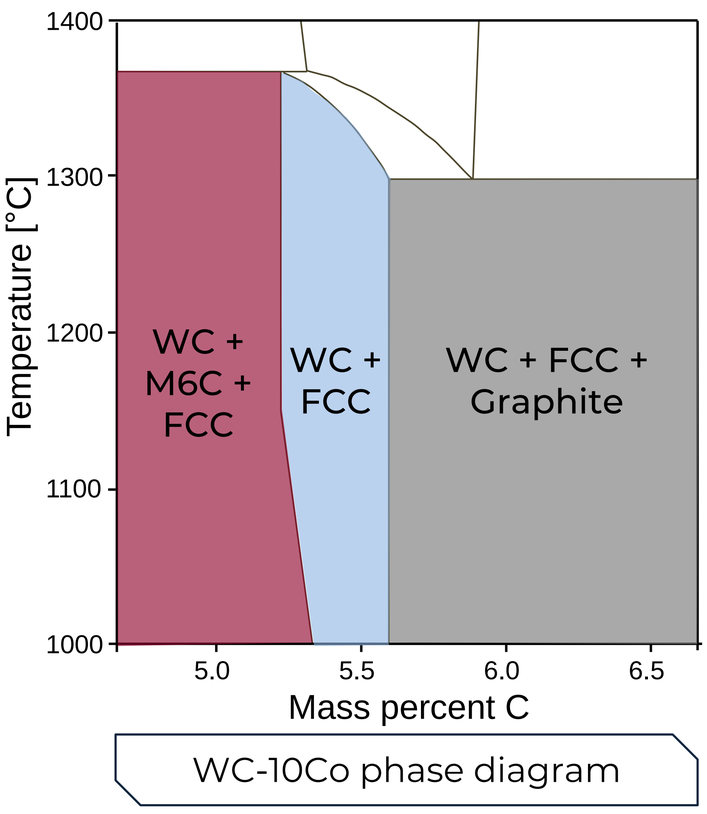
The currently-used binder is cobalt. However, cobalt is known to be :
- » a strong carcinogenic and neurotoxic material
- » extracted in Democratic republic of Congo a critical element.

These are the reasons why **alternatives to cobalt as a binder for WC** must be found. To find alternatives to cobalt, two steps are required:
- » Phase diagrams generation
- » Creation of the composite and mechanical properties determination





Simulations



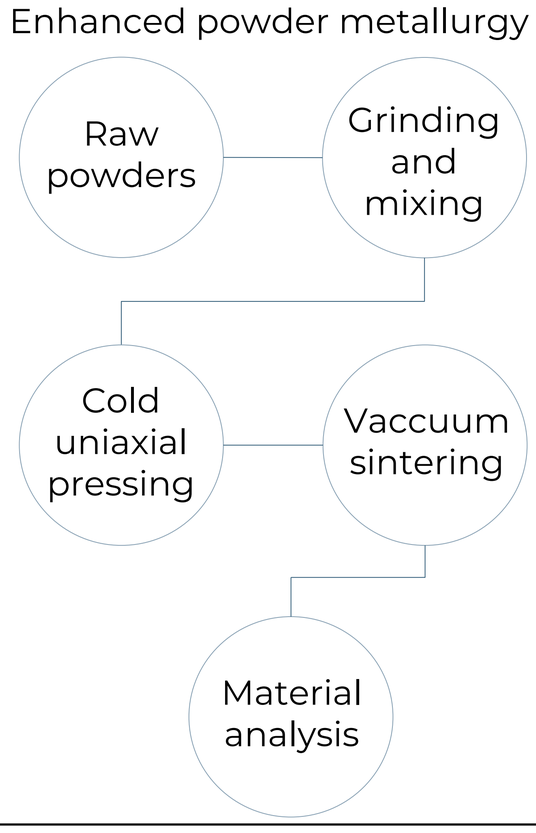
WC-10Co phase diagram

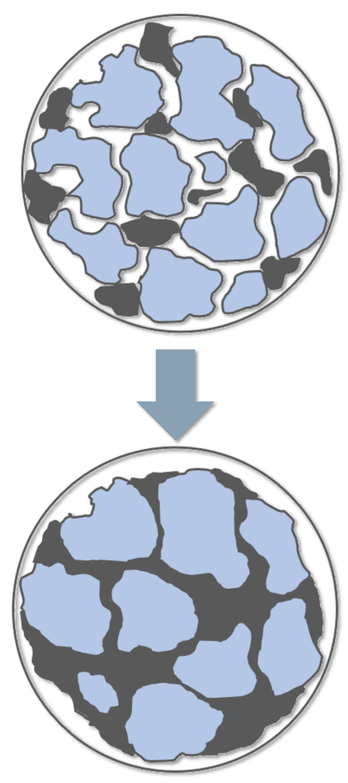
WC composites possible phases:
- » WC: high hardness
- » η phase (M_6C): low toughness
- » Binder phase (FCC): ensures cohesion
- » Graphite (must be avoided)

Expected results
- » WC + Binder microstructure;
- » Reduced grain size
- » Hardness > 1600 HV_{30}
- » Toughness > 8 $MPa.m^{1/2}$
- » Satisfactory corrosion and wear resistances

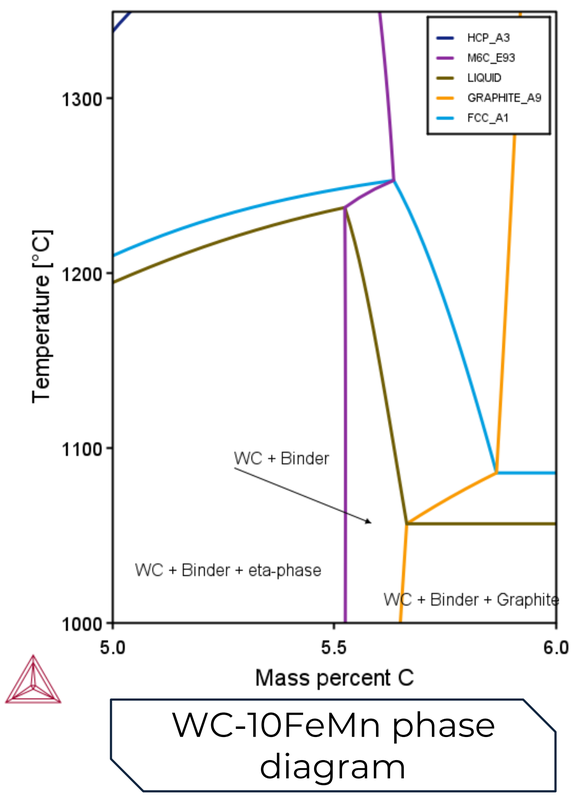
Processing

Enhanced powder metallurgy

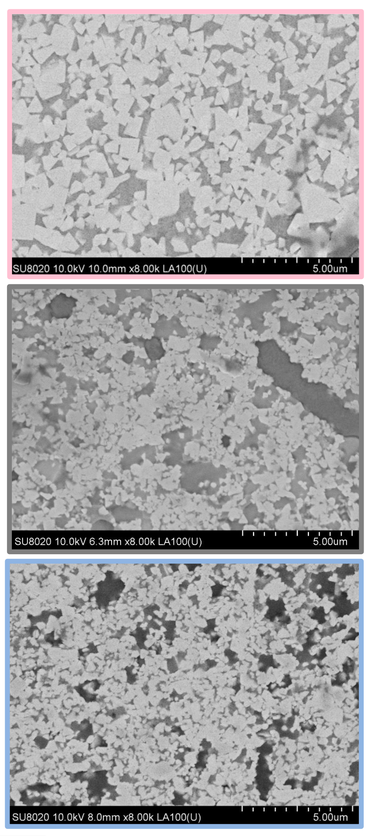




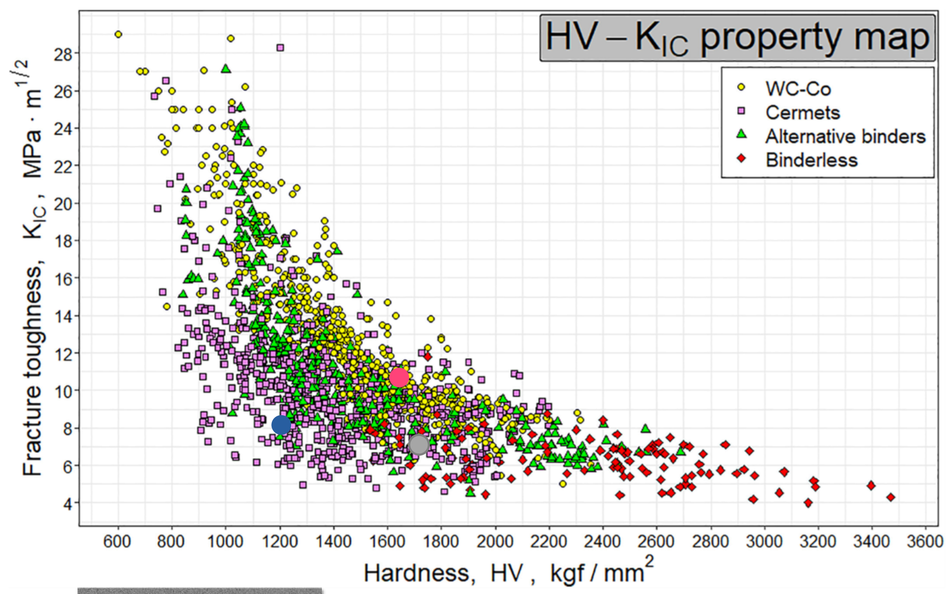
Results and characterizations

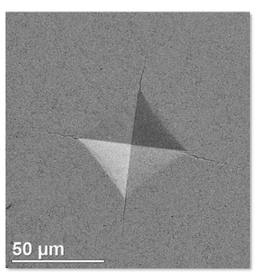


WC-10FeMn phase diagram



Samples	Hardness HV_{30}	K_{IC} ($MPa.m^{1/2}$)
WC – 10 Co	1618 +/- 81	11.31 +/- 0.61
WC – 10 FeMn	1760 +/- 75	7.61 +/- 0.35
WC – 10 FeNi	1214 +/- 222	8.55+/- 0.53





Palmqvist method

Conclusions & perspectives

WC-10FeMn is a strong candidate as an alternative binder for WC, but only if :
- Process is optimized:
  - Grinding: more homogenous mixing by adaptation of grinding parameters
  - Sintering: eventual parameters or sintering technique modification
- Corrosion and wear resistance show satisfactory results (at least as good as WC-Co alloys)