





Study Of Niobium Carbide As Grain Growth Inhibitor In Cemented Tungsten Carbides

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Context

- 1. Mechanical properties of tungsten carbides depend on
 - Density of the parts.
 - WC grain size (Hall-Petch).



- 2. Use of Grain Growth Inhibitors
 - Carbides from the transition metal groups IV to VI.
 - VC and Cr_3C_2 are effective and well-studied.
 - NbC provides medium hardness but high fracture toughness and transverse rupture strength.
- 3. Interesting alternative to VC and Cr_3C_2

Method

- Two-step ball milling (ethanol, ball-to-powder ratio 4:1)
 - 1. Inhibitors doped-cobalt powders: 600 rpm, 10 h
 - 2. WC + doped-Co powders: 300 rpm, 6 h
- Vacuum sintering at 1400°C (1h)

20 wt.% inhibitor in the cobalt powder 10 wt.% binder in the WC composite No GGI / VC / Cr₃C₂ / NbC / NbC+VC / NbC+Cr₃C₂

Results







No GGI



racture toughness (MF

VC

The addition of NbC improves mechanical properties of WC-10Co parts.

• Disadvantage of NbC: high price but possibility of combination with other GGI.

NbC



NbC+Cr₃C₂

Effects of VC

• Decrease of WC grain size

NbC+VC

- Decrease of sinterability
- \rightarrow Lower hardness than expected





Effects of Cr₃C₂

Cr₃C₂

- Decrease of WC grain size
- Promotion of Co pools
- \rightarrow Lower toughness than expected

Conclusion

• The combination of NbC and Cr_3C_2 provides an interesting hardness to toughness ratio.

References

- Liu et al., Complexions in WC-Co cemented carbides., Acta Materialia, 2018
- Farag et al., The influence of grain growth inhibitors on the microstructure and properties of submicron, ultrafine and nano-structured hardmetals – A review, IJRMHM, 2018

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