

Master 2 (or equivalent) Internship Opportunity

Optimisation of sinter-based additive manufacturing of cemented carbides for cutting tool applications

Context & Objectives: This topic supports an ongoing PhD thesis aiming to evaluate the effect of powder recycling on both the conventional and additive manufacturing of cemented carbide components. In the case of additive manufacturing, components are shaped by extruding pellets containing both the desired powder and polymers that facilitate shaping. The polymers are then removed chemically and thermally, after which the parts are densified by sintering until they reach their final dimensions and properties. Whilst such processes are beginning to be studied to produce cemented carbide parts, the various stages of the process using pellets formulated by SECO still need to be optimised in order to minimise porosity [1, 2], prevent the formation of cracks and bubbles [3], and achieve the best possible balance in terms of the 'composition-microstructure-properties' combination compared with conventional manufacturing methods. This parametric optimisation will begin with the reference pellets (i.e. those without recycled powder) and may be based on experimental designs already developed in the laboratory for other materials.

Work program

- Literature review on sinter-based additive manufacturing of WC-Co
- Development of a design of experiments aiming to optimise the shaping step of the process (extrusion) for simple (parallelepiped) components using the raw material supplied by SECO (geometric accuracy, density of green components, etc.)
- Optimisation of the polymer debinding cycle using thermogravimetric analysis
- Assessment of densification kinetics during sintering using dilatometry tests
- Optimisation of debinding-sintering cycles (time, temperature, atmosphere), focusing in particular on their impact on the final composition (carbon content) and microstructure
- Characterisation of the densities, microstructure and hardness obtained (X-ray tomography, optical and scanning electron microscopy, Vickers hardness)
- *Depending on the time, production of parts from recycled carbide powders.*

The internship, funded by Seco Tools company (Fagersta, Sweden), will take place at the SIMaP laboratory, in collaboration with the Polytechnic University of Catalonia (Barcelona). The expected duration is 6 months, with a stipend of around 693 euros per month (4.50 euros per hours). To apply, please send your CV and your academic transcripts for the last two years.

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References

- [1] Lengauer, Walter, et al. "Fabrication and properties of extrusion-based 3D-printed hardmetal and cermet components." *International Journal of Refractory Metals and Hard Materials* 82 (2019): 141-149.
- [2] Chen, Cai, et al. "Material extrusion additive manufacturing of WC-9Co cemented carbide." *Additive Manufacturing* 86 (2024): 104203.
- [3] Zhao, Zai, et al. "Material extrusion printing of WC-8% Co cemented carbide based on partly water-soluble binder and post-processing." *Journal of Materials Research and Technology* 29 (2024): 4394-4405.