Title	**Microstructure and properties of WC- and NbC-based alternatives hardmetals**
Main host laboratory	Université Grenoble Alpes (UGA) Laboratory : SIMaP, Science, Engineering, Materials and Processes https://simap.grenoble-inp.fr/en
PhD supervisors	C. Pascal (UGA), R. de Oro Calderon (TU Wien), J.-M. Missiaen (UGA)
Field of expertise	Materials Science
Context	A hardmetal (or cemented carbide) is a composite material, manufactured by powder metallurgy route, that combines the high hardness of a hardphase (usually a carbide), with the ductility of a metallic binder. Currently, the combination WC-Co is by far the most used one. However, the material that revolutionized the tooling industry a few decades ago is nowadays facing an enormous challenge: the need to replace Co as binder according to a reclassification by REACH (European Chemical Agency) due to its toxicity and environmental issues. After many years of research on alternatives, it is nowadays rather clear that there will not be a one-single alternative to Co that can cover such a wide range of applications. In the future, different applications will require different combinations of hardphase and binder that can respond to the specific needs. Todays research can be supported with the use of modelling tools. There is a growing interest in the so called “Integrated Computational Materials Engineering – ICME” discipline, which aims to capture the knowledge of materials scientist and engineers into software tools, in order to predict the links between chemical composition, processing routes, microstructures and properties. However, further advances are, in many cases, prevented because there is insufficient or inconclusive experimental data to support the development of these models. Within this project, we aim to stablish a fruitful collaboration between modelling and experimental groups that would cover expertise on production, advanced microstructural analysis, mechanical characterization and modelling. We propose to explore the field of alternative hardmetals (i.e. containing alternative binders and/or alternative hardphases) starting from a fundamental understanding on the chemical and microstructural parameters that control the mechanical properties, and then using this information to “tailor” the composition of novel materials to provide the required properties for a targeted application.
Description	The main objective of the project is to understand how the microstructure-property relationship can be controlled, in order to develop alternative hardmetals. The three sub-objectives are: (1) to identify substitute binders that can influence the microstructure and properties in an efficient manner; (2) to elucidate the effect of carbide grain size on properties; and (3) to improve predictive models using new experimental data. After selection of promising hardphase/binder combinations, hardmetal samples will be produced using powder metallurgy route in conditions close to industrial one. Afterwards, a detailed microstructural study will be carried out as follows:

	- Shape, morphology and distribution of the hardphase, binder phase, secondary phases and porosity will be observed using SEM (Scanning Electron Microscopy). - Hardphase grain size distribution and contiguity will be determined from EBSD micrographs (Electron BackScattered Diffraction) and the faceted/rounded character of hardphase/binder interfaces will be quantified. - Hardphase/binder interfaces and hardphase/hardphase grain boundaries will be observed using TEM (Transmission Electron Microscopy), in particular to locate possible segregations or precipitations of secondary carbides or intermetallic phases. Grain growth and grain growth inhibition mechanisms during sintering will be analyzed for WC-based and NbC-based hardmetals, using binders with different chemical compositions. The study will consider the effect of binder chemistry, carbon content, binder volume fraction, initial particle size of the hardphase, sintering time (kinetics) as well as the addition of grain growth inhibitor. The effect of grain size and binder content on properties will be analyzed for selected combinations of materials. *Strong collaboration with a PhD at TU Wien is included in the project. Two scientific stays (6 months and 5 months) are planned at TU Wien where samples will be produced and their mechanical properties evaluated.*
Candidate profile and skills	The candidate, motivated by scientific research, will hold a Master degree in Materials Science or an equivalent diploma. He/she should have a sound knowledge in Materials Science and particularly in Metallurgy. Knowledge of microstructural characterization techniques is essential. An interest or skills in modelling are welcome. Technical English is also required. In addition to their scientific skills, the candidate must be able to work in a team, but also have a degree of autonomy.
Funding and starting date	The thesis will start in September 2024 and will be funded by the ANR PRCI (collaborative research projects between public Austrian and French entities) for a period of 36 months. Gross salary per month ~ 2135 € / Net salary per month ~ 1715 €. Accommodation costs during stays at TU Wien will be covered by the laboratory.
How to submit an application?	The application must include, in single PDF document, a CV, the transcripts of marks for the Bachelor and Master degree, a 1-page document presenting your last internship project and, if you wish, one or more letters of recommendation. Applications will be pre-selected before an interview by videoconference. *For further information, please contact Céline PASCAL :* *Celine.Pascal@simap.grenoble-inp.fr* *Deadline for application:* May 15th, 2024