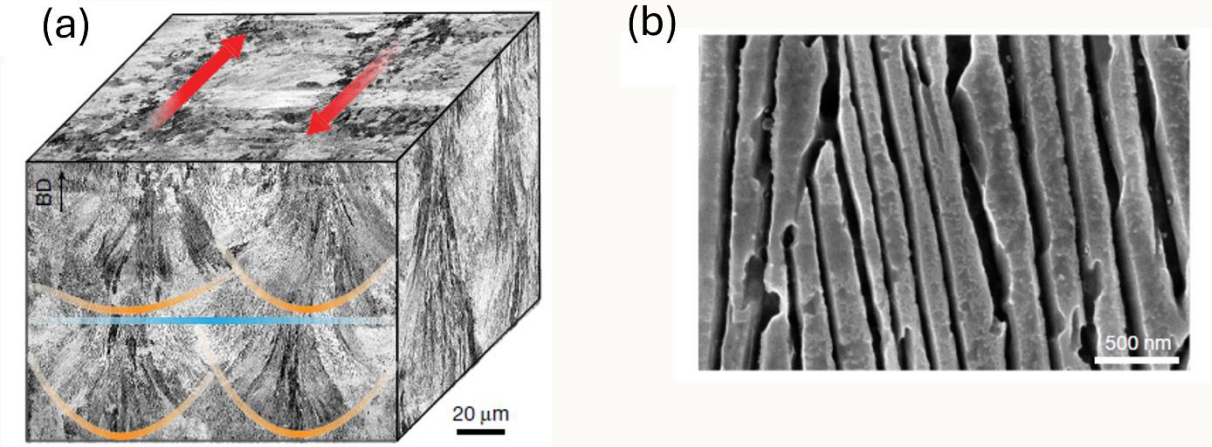
Phd position 2025- CEMEF

Doctoral speciality	*"Numerical Mechanics and Materials - MNM"*
TITLE	Development of a new multiphase grain structure model and application to additive manufacturing of high entropy alloys
Project acronym	EUTHEAM
Key-words	Materials, additive manufacturing, modeling, experiments
Context	Eutectic structures are defined as multiphase solid structures that are formed from a liquid as it cools. The formation of these structures is characterized by the development of a pattern of increasing fineness in accordance with the rate of solidification. These materials are therefore natural composites that, when combined with additive manufacturing processes, can be used to produce very fine composite structures, thereby opening up a whole new range of combinations of thermo-mechanical properties. In contrast to the majority of eutectic systems that have been previously encountered, the novel high-entropy alloys are capable of forming stable eutectic structures at elevated temperatures: EHEAs. So the combination of the EHEA boom and additive manufacturing offers fertile ground for the development of innovative materials with enhanced added value [1] for various strategic domains.
Detailed presentation with figure(s)	 *Figure 1: (a) optical micrograph of a grain structure generated by additive manufacturing (b) zoom on the intragranular 2-phase eutectic structure [1]* However, this development faces an obstacle: there is currently no model that can predict the structures formed in eutectic materials on the scale of a part. The objective of the proposed PhD project, which was selected through the ANR 2024 call for projects, is to develop a model of eutectic grain structure and to evaluate it by comparing it with experimental data. This model, inspired by the CAFE method that has been successfully applied to dendritic structures [2], will use finite element and cellular automaton modelling by implementing the growth theories of eutectic structures. Furthermore, other techniques based

	on front-tracking approaches, which are more expensive than cellular automaton approaches but also more precise, will be considered on limited volumes depending on the progress of work. The PhD student will also be involved in carrying out and analyzing experiments on an EHEA alloy and a model binary alloy. Please do not hesitate to contact us if you have any questions about this project.
Bibliography references	1] Ren, J., et al. (2022). Strong yet ductile nanolamellar high-entropy alloys by additive manufacturing. *Nature*, *608*(7921), 62-68. [2] Camus, T., Maisonnette, D., Baulin, O., Senninger, O., Guillemot, G., & Gandin, C. A. (2023). Three-dimensional modeling of solidification grain structures generated by laser powder bed fusion. *Materialia*, *30*, 101804.
Gross annual salary	26400€/year before charges
Project type/ cooperation	3-year fixed-term contract. Beggining : october-november 2025
Skills, abilities requested	Engineering school or master degree with materials science specialty. Some programming experience is desirable.
Location	CEMEF-Mines Paris, Sophia Antipolis (France)
CEMEF team(s)	MSR
Supervisor(s)	Oriane SENNINGER : oriane.senninger@minesparis.psl.eu Marc BERNACKI : marc.bernacki@minesparis.psl.eu

To apply: You can only apply online by filling in the CEMEF online form on :

https://applyfor.cemef.mines-paristech.fr/phd/