PhD Thesis - COCASSE project

Job title	COmplex Concentrated Alloys : Sintering and assembly
Job type (PhD, Post-doc, Engineer)	PhD
Contract	36 months 1600 € net/month
Qualifications (Master, Ph.D …)	Master
Job hours (full time/ part time)	Full Time
Employer	UBFC Université Bourgogne Franche-Comté
Financing Institutions	Graduate School EIPHI & Region Bourgogne Franche Comté
Host Laboratory	FEMTO-ST
URL Host Laboratory	https://icb.u-bourgogne.fr/
Address Host Laboratory	Laboratoire Interdisciplinaire Carnot de Bourgogne 9 avenue Alain Savary BP 47870, 21078 Dijon
Job description	The objective of this work is to study the fabrication of High Entropy Alloys (HEA) and their weldability by laser beam. Unlike "conventional" alloys composed from a predominant element, HEA contain at least 5 metallic elements, the proportion of which is between 5 and 35% at. This offers great flexibility in the development of new materials with a wide variety of compositions. Indeed, the "disorder" present in the atomic organization by several elements with similar or very similar atomic properties gives them extraordinary mechanical or electrical properties, well beyond known values. Different UBFC teams have techniques for developing these types of materials. The principle is to start from a precursor material in powder form (multi-elements) which can be obtained either by atomization (larger production volume) or by high energy ball milling (to vary the nuances more easily). These multi-element powders can then be 3D structured by different processes: powder metallurgy (SPS sintering), additive manufacturing (laser fusion) or in the form of thin deposition (PVD). Moreover, in order to extend the applications of HEA, their assembly in systems of similar or different materials constitutes one of the challenges of this work. The thesis will be divided into several phases: Phase 1: Development of HEA by powder metallurgy (Dijon) - A previous study made it possible to synthesize HEAs of the AlCoCrFeNi family, by SPS reactive sintering of elementary powders premixed during high energy ball milling. It was possible by varying the composition of the HEA to obtain

	different metallographic structures (FCC structure, FCC / BCC duplex structure, BCC1 + BCC2 structure). A change of scale will make it possible to manufacture these HEAs to study their weldability. - Other means of production will then be used: in particular gas phase atomization (UTBM) for the production of the powder and laser micro-melting on a powder bed (UTBM) for the production of bulks. This will allow, on the one hand, comparing two shaping processes independently of the powder and, on the other hand, to assess the impact of a powder preparation method on the SPS process. Phase 2: Study of laser weldability (Le Creusot) - Mastery of the assembly of HEA materials by adapting the laser parameters to the structure of a material manufactured by different processes. It has been already observed that, for a same material produced by different ways (foundry alloy or sintered material), the assembly parameters could be different. We can already predict that the elaboration processes will lead to various microstructures, and thus to differences with respect to the durability and mechanical properties of the welded system. It is therefore important to correlate the process of elaboration of the material, the microstructure (and the thermophysical properties of the material to be welded) to the phenomenology of the laser-material interaction and then study the impact of the welding on the microstructure of the assembly. The study will begin with an understanding of the weldability of two HEA materials from the same family. In this case, it will be possible to observe a depletion of certain elements in the molten zone following the selective vaporization (analyses by atomic emission spectrometry can allow quantifying this phenomenon). Next, the coupling of two different HEA materials will be examined. - Influence of the welding on the microstructure and the properties of the material. The characterizations will focus on the evolution of chemical compositions and structures during the various process phases, as well as on the mechanical properties (hardness, resistance, etc.) and high temperature oxidation before and after assembly by welding. In situ instrumentation during the processes will be considered.
Supervisor(s)	Supervisor : Pierre SALLAMAND (PU) - ICB/PMDM - LTm (Le Creusot) Co-supervisor : Sophie LE GALLET (MCF) - ICB/PMDM - MANAPI (Dijon)
Candidate profile	The Ph-D student should have a solid scientific and technical background in which he/she will have acquired the basics relating to metallic materials. Experience in this area would be desirable as well as in the elaboration and / or treatment processes. The Ph-D student is the unifying element of this project. He/She must be mobile and able to adapt to different organizations (teams are located in remote places in Bourgogne-Franche Comté). In addition to his research work, the Ph-D student will invest in presenting to the scientific community and the public the

	impact of HEAs, of their method of development on the properties of materials.
Keywords	
Application deadline	15/06/2021
Application Depending on the type of position	The doctoral fellowship is 3-year fellowship funded by EUR-EIPHI and BFC-Region Interested candidates may send their application to Pierre.Sallamand@u-bourgogne.fr Applications must contain: • An academic CV • A cover letter/statement of purpose • At least two letters of recommendation • A transcript of records for the past two years