MATERIALS SCIENCE AND TECHNOLOGY

FOMAS S.p.A. - Study and optimization of vacuum induction melting processes on metallic materials

Funded By	FOMAS S.p.A. [P.iva/CF:12216260153]
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Context of the research activity	The aim of the project is to study the metallurgy of vacuum induction melting process and the related casting of high added value alloys, like Fe, Co and Ni superalloys. Both the theoretical and practical aspects of this process will be addressed, starting from trials at a laboratory levels up to follow the functioning of a real scale industrial furnace. The parameters optimization will be done by considering typical problems of selective volatilization of alloying elements as well as their segregation in the casting stage.
Objectives	The project will be developed in tight collaboration with FOMAS S.p.A., a company with more than 1500 personnel working in the manufacturing of forgings and seamless rolled rings, in any type of steel and non-ferrous alloys. FOMAS is active in different market sectors, the most relevant being power generation, oil & gas and mobility. Vacuum induction melting is a process developed to manage high added value metallic alloys, rich in noble and, frequently, critical alloying elements. The major benefit of such process is the capacity to minimize the residual elements content, especially that of gas and volatile species, guaranteeing the quality of the final metallic grade. This process is practically essential for fabricating the metals devoted to the energy and aeronautic sectors. The metallurgical complexity of such alloys makes the melting and casting process very critical. Within the current project the induction coupling with the raw material first and with the melt later, will be studied considering both theoretical and practical aspects, like for example the shape and nature of scraps used to charge the furnace. The eventual unintended losses of alloying elements will also be studied and physically modelled to predict the evolution of this phenomenon during the melting stage according to alloy composition, temperature, time and operating pressure levels. The optimization of the induced currents flow through the melt and the crucible-melt interface and interaction will also be addressed, to predict the level of homogeneity and the eventual contamination of the melt. Finally, the solidification structure as well as the segregation effects and patterns will be investigated as a function of solidification time and other parameters. Whenever it will be possible, physical models of the effect of process parameters on the metallurgical

	quality will be developed. These phenomena and their related behaviour prediction models will be studied within laboratory scale trials and then upscaled to relevant environment which better represents the industrial operative condition. Finally, the developed knowledge will be transferred to the industrial environment to manage the use of a real scale vacuum induction plant used to fabricate Fe, Co and Ni alloys. Besides the metallurgical quality, the industrial process will be studied according to its yield and to its sustainability evidencing the aspects related to the recycling and efficient use of critical raw materials and high added value metallic alloys. The PhD project intends to train a professional profile very skilled on vacuum induction melting and the following casting techniques applied in the metallurgy field, combining theory and practice both at laboratory and industrial levels. The ultimate result of the project will be the improvement of productivity and reliability of manufacturing for strategic sectors that represent the most relevant market applications for FOMAS. Additionally, the project will pave the way to introduce the FOMAS finely controlled products in new markets, like for example the aeronautics.

Skills and competencies for the development of the activity	An academic background on materials science and, especially, on metallurgy is required. Good knowledge of austenitic stainless steels and nickel superalloys microstructural features and properties as well as their applications are welcome. Knowledge and competences on the melting processes of advanced metallic alloys and the related metallurgical and practical problems related to such production route are highly appreciated. Good expertise on metallic materials characterization techniques are also requested.