MATERIALS SCIENCE AND TECHNOLOGY

DM 630/FOMAS - Average Austenitic Grain Size Estimation with Ultrasonic Method compared with standardized method

Funded By	FOMAS S.p.A. [P.iva/CF:12216260153] MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584]
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Context of the research activity	The project will develop a non destructive method using Ultra Sound (US) waves to assess the grain size of austenitic stainless steels and nickel superalloys. The grain size defines the ultimate properties of metallic materials and is currently checked with destructive and long procedure. US control is widely used to check the presence of internal defects in metallic products, but their use for grain size assesment requires a project involving physics, metallurgy and US source technology. Progetto finanziato dal PNRR a valere sul DM 630/2024 - CUP E14D24002460004
	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. The current project aims at developing a non destructive method using Ultra Sound (US) waves to assess the grain size of austenitic stainless steels and nickel superalloys. These are high added value materials, rich in alloying elements which belong to the Critical Raw Materials (CRMs) list. They are extensively used in the fabrication of medium to big size components for strategic sectors like nuclear and energy production in general. The product certification of such components is essential to guarantee their reliability. The grain size is a key factor to define the ultimate properties of metallic materials and is currently checked with destructive and long procedures, that are highly affected by operator's sensitivity. Additionally, the current checks are performed on relatively small test coupons extracted from specific parts of the component, thus, not always fully representative of the whole big size

Objectives	and complex profile component quality. The improvement of online non destructive control methods would, therefore, provide higher productivity and will limit the risk of discarding or re-working components which are suspected to be not conformal. This last consideration is particularly important in view of the extended use of CRMs in such products and of the size of typical components used in the reference application sectors. On the other hand, the application of a non destructive online testing would improve both the confidence in providing products certification and the reliability of specific components and of the overall industrial production, providing enhanced reputation to the company. The US control is widely used at industrial level to check the presence of internal defects in metallic semiproducts and products. Some applications of US to grain size assesment are reported in literature. These works are characterized by research approach and have many limitations in terms of the actual possibility to apply the developed method to different grain sizes and to any product dimensions and profile. To extend at an industrial level the application of US to grain size assesment requires a multidisciplinary project involving the physics of ultrasonic waves, their interaction with reference metallurgical structures and the ultrasonic waves sources/probe technology and management. Numerical simulation of ultrasonic waves propagation in the matter will aslo be applied within the PhD project. Furthermore, the results of the developed methodology will have to be compared and cross checked with the traditionally applied standardized destructive methods. The applicability of the method to different grain size and the measurements uncertainties will have also to be assessed within the project. The PhD project intends to train a professional profile very skilled on destructive and non destructive methodology applied in the metallurgy field, combining theory and practice both at laboratory and industrial level. The ultimate result of the project will be the improvement of productivity and reliability of manufacturing for strategic sectors that represent the most important market application for FOMAS. Additionally, the project will pave the way to introduce the FOMAS finely controlled forged 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 features and applications are welcome. Knowledge and competences on metallic materials characterization are considered of relevant importance. The knowledge of hot forging process and, especially, its application to the manufacturing of big size components with the related material quality problems are also highly appreciated.