Advanced characterization by atomic (neutron) techniques: probing nano/micro-structural parameters with real-world impact

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ABSTRACT

The advancement of industrial materials and components strongly depends on effective characterization methods capable of linking macroscopic functional properties with nano- and microstructural features. Neutron beam techniques (NBT), non-destructive and non-invasive, represent powerful tools to probe such relationships, overcoming many limitations of conventional analysis methods. At the Rogante Engineering Office (REO), dedicated methodological approaches procedures are developed to broaden the industrial applicability of these atomic techniques. NBT provide fundamental insights into key physical parameters linked to performance, degradation and overall quality, supporting improvements in properties and functionality. Their impact is increasingly significant in both industrial and medical fields, e.g., in the study of invasive medical devices, which require to assess aging and defect evolution. Similar demands exist in various industrial sectors, where components must guarantee long-term durability and structural reliability. NBT, added to classical analyses, offer complementary diagnostics that strengthen quality control, and promote the development of new-generation materials. By bridging microstructural characterization with macroscopic behavior, they enable optimization of design, performance and service life of both biomedical and industrial products. This paper presents new case studies carried out by the REO, e.g., illustrating advanced nano/micro-characterization of duplex stainless steels for biomedical applications and high-entropy alloys fabricated by wire arc additive manufacturing. These examples highlight the broad potential of NBT to drive technological progress and deliver real-world impact.

BIOGRAPHY

Dr. Ing. Massimo Rogante, B.Eng. (Mech.), Ph.D. in Nuclear Engineering, is Director of the Rogante Engineering Office, landmark for application of neutron techniques in the industrial and cultural heritage topics. With ~30 years of experience in the neutron field, he is an active member of several leading international organizations, including the Int. Scientific Advisory Council of the Budapest Neutron Centre and the Scientific Selection Panel of the CANAM at the Nuclear Physics Institute of the Czech Academy of Sciences. He has contributed to various international and national projects, published over 360 scientific papers and frequently serves as invited lecturer, scientific committee member and co-organizer at int. conferences and workshops. He is also a Maestro of piano.

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