Frontiers of Research in NDE

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Abstract

Research is normally defined as original investigation undertaken in order to gain knowledge and understanding. Research can be work of direct relevance to the needs of the particular field, qualitative or can be based on fundamental analysis. Frontiers of Research refers to the invention and generation of ideas including design, where these can lead to new technologies or improved materials and processes or substantially improve insights of fundamental mechanisms.

Non destructive evaluation (NDE) is the scientific use of nearly all known physical principles to study the fitness-for-service of a material, component, or assembly of parts without impairing its intended use. Traditionally, NDE techniques have been used for detection of defects in materials and components right from the raw material stage through fabrication, processing, assembly and after the component is put into service. In short, akin to medical diagnostics NDE is practised in industry right from cradle to tomb of components. With the development of advanced and smart materials, efficient designs, closer tolerance of material properties and imposition of stringent specifications, industries of this century are facing challenging demands. Emphasis is given to achieve stringent quality, enhanced material performance, higher reliability and safety. It is also becoming increasingly evident that it is both practical and cost-effective to expand the role of NDE to include aspects of materials characterisation, production and application and to introduce NDE much earlier in the design stage.

Innovative concepts and novel NDE technologies are thus the need of the hour. In response to the need of the engineering and scientific communities, non-destructive testing and evaluation (NDT&E) has emerged as one of the most rapidly developing areas of research and development world wide. This is evident from the number of institutions offering advanced courses and encouraging masters and doctoral programs in NDE.

NDE research is unique and different. NDE research is virtually an interdisciplinary field encompassing physics, material science and metallurgy, electronics, sensors and measurement systems, computers and robotics to develop reliable and robust technologies for testing and evaluation of materials and components during manufacturing as well as during service life. While multidisciplinary research is interesting and intriguing, the integration of various branches is also quite challenging. It is rather difficult, if not impossible, to carry out comprehensive NDE research encompassing all the above aspects under one roof.

Current research areas in NDE are in the development of advanced sensors; on-line process control through automation and application of artificial intelligence concepts;, NDE modelling and simulation; materials characterization using powerful probing media such as synchrotron sources; residual life assessment and life-cycle management of components and structures through miniature wireless sensor networks and robotics. With the on-going emphasis on nano materials and structures, NDT has approached the nano-dimension and NEMS (nanoelectromechanical systems) are already drawing much greater attention.

This talk would focus on the frontier research areas being pursued at the Indira Gandhi Centre for Atomic Research, Kalpakkam. Interesting case studies relating to development and application of novel methods and techniques based on physical principles for solving challenging engineering problems; numerical modelling of remote field eddy

current phenomena based on finite element analysis for optimisation of probe design; synergising robotics with sensors and image /signal processing for reliable in-service inspection; application of magnetic Barkhausen emission for characterisation of microstructures and development of thermal imaging and photo-thermal methods for materials characterisation would be highlighted. The talk will also provide a global view of emerging international NDE scenario such as development of phased array transducers in ultrasound imaging with staggered firing capability and very good near-field and far-field resolution, NDE simulation tools and terahertz imaging. Finally, the talk would also highlight based on authors extensive experience, how multi-disciplinary approaches with coherent synergism among various disciplines can result in frontier research getting converted to successful and mature technologies for industrial and societal applications, thus ensuring safety of components and better quality of life on the earth.