

Development of Ultrasonic Transducer For In-Situ High Temperature Inspection

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Abstract

The objective of the work presented here is the development of an ultrasonic transducer which works under in-situ high temperature conditions in Liquid Metal Fast Breeder Reactor (LMFBR). The authors have previously demonstrated the working of contact-type high temperature transducer for under sodium viewing. Key features of this design are rugged outer casing and pressure contact. However, in extending this approach for direct defect characterization, the key challenges are in improving working temperature range of the active element and prevention of debonding of interfaces within the transducer. Hence, two solutions are proposed, a high temperature transducer with active elements Lead Zirconate Titanate (PZT) and Lead Meta Niobate (LMN or PbNb_2O_6) and the other with thin-film PZT active element. The advantages and disadvantages of these approaches are detailed.

Introduction

Non-Destructive Evaluation (NDE) of nuclear reactor structures is essential to ensure safe working conditions. Conventional NDE is performed during dedicated maintenance as most current methods require plant shut-down to let structures and components to cool. In-service continuous monitoring is thus of much interest to reduce downtime. A variety of methods have been investigated over the years. Ultrasonic inspection has proved to be very efficient and reliable in detecting and monitoring growth of defects [1, 2]. Ultrasonic sensors operating at high temperature have been developed for particular applications like NDE of hot steel plates and pipes, wall thickness measurement, weld inspection [3] and long term measurements in a liquid Pb/Bi alloy [4].

This paper is based on a current research by the authors to address the problem of in-service monitoring of structures at 200 °C. Two solutions are proposed to this problem: the first, development of an ultrasonic transducer with elements Lead Zirconate Titanate (PZT) and Lead Meta Niobate (LMN or PbNb_2O_6), and the second, with thin-film PZT active element. This paper is organized as follows: the components of the prototype ultrasonic transducer and their functions are explained in the section under *proposed design*. However, the prototype ultrasonic transducer with PZT and LMN disc-active element faced a major drawback during continuous high temperature operation: the evaporation of couplant between the active element and the

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Sensors for Ultrasonic NDT in Harsh Environments Anthony N Sinclair, Robert E. Malkin, 2020-05-13 In this Special Issue of Sensors seven peer reviewed manuscripts appear on the topic of ultrasonic transducer design and operation in harsh environments elevated temperature high gamma and neutron radiation fields or the presence of aggressive chemicals Motivations for these research and development projects are strongly focused on nuclear power plant inspections particularly liquid sodium cooled reactors and nondestructive testing of high temperature piping installations It is anticipated that extensive use of permanently mounted robust transducers for in service monitoring of petrochemical plants and power generations stations quality control in manufacturing plants and primary and secondary process monitoring in the fabrication of engineering materials will soon be made

Expanding the Vision of Sensor Materials National Research Council, Division on Engineering and Physical Sciences, National Materials Advisory Board, Commission on Engineering and Technical Systems, Committee on New Sensor Technologies: Materials and Applications, 1995-06-22 Advances in materials science and engineering have paved the way for the development of new and more capable sensors Drawing upon case studies from manufacturing and structural monitoring and involving chemical and long wave length infrared sensors this book suggests an approach that frames the relevant technical issues in such a way as to expedite the consideration of new and novel sensor materials It enables a multidisciplinary approach for identifying opportunities and making realistic assessments of technical risk and could be used to guide relevant research and development in sensor technologies

Electrically Conductive Membrane Materials and Systems Farah Ahmed, Raed Hashaikeh, Nidal Hilal, 2023-05-04 *Electrically Conductive Membrane Materials and Systems* offers in depth insight into the transformative role of electrically conductive materials in membrane separation processes for desalination and water treatment The book focuses on the intelligent design of conductive membranes and systems fouling and related phenomena fouling control using electrically conductive materials and electrically tunable membrane systems for microfiltration ultrafiltration nanofiltration reverse osmosis and membrane distillation With rising concerns around inaccessibility to freshwater and the ever increasing threats of population growth climate change and urban development the book brings electrically conducting materials to the forefront of membrane separation technology with an emphasis on their role in the mitigation of fouling and related phenomena Electrically conducting materials expand the versatility of membrane technology and ultimately improve access to safe water The book is important reading for scientists engineers entrepreneurs and enthusiasts from the water industry who seek to familiarize themselves with a groundbreaking area of study within modern desalination and water treatment Explores novel membrane materials and systems from preparation methods materials selection and their application in monitoring fouling control and performance enhancement Examines the mechanism of fouling prevention and cleaning in various electrically conductive materials Evaluates the scalability of antifouling materials and coatings as well as electrically

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Current Trends and Future Developments on (Bio-) Membranes Angelo Basile,Alfredo Cassano,Navin Kumar Rastogi,2019-09-15 Current Trends and Future Developments on Bio Membranes Reverse and Forward Osmosis Principles Applications Advances covers the important aspects of RO FO and their combination in integrated systems along with their specific and well established applications The book offers an overview of recent developments in the field of forward and reverse osmosis and their applications in water desalination wastewater treatment power generation and food processing General principles membrane module developments membrane fouling modeling

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Jerome P. Lynch, Hoon Sohn, Ming L. Wang, 2014-04-26 Sensors are used for civil infrastructure performance assessment and health monitoring and have evolved significantly through developments in materials and methodologies Sensor Technologies for Civil Infrastructure Volume I provides an overview of sensor hardware and its use in data collection The first chapters provide an introduction to sensing for structural performance assessment and health monitoring and an overview of commonly used sensors and their data acquisition systems Further chapters address different types of sensor including piezoelectric transducers fiber optic sensors acoustic emission sensors and electromagnetic sensors and the use of these sensors for assessing and monitoring civil infrastructures Developments in technologies applied to civil infrastructure performance assessment are also discussed including radar technology micro electro mechanical systems MEMS and nanotechnology Sensor Technologies for Civil Infrastructure provides a standard reference for structural and civil engineers electronics engineers and academics with an interest in the field Describes sensing hardware and data collection covering a variety of sensors Examines fiber optic systems acoustic emission piezoelectric sensors electromagnetic sensors ultrasonic methods and radar and millimeter wave technology Covers strain gauges micro electro mechanical systems MEMS multifunctional materials and nanotechnology for sensing and vision based sensing and lasers

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