

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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