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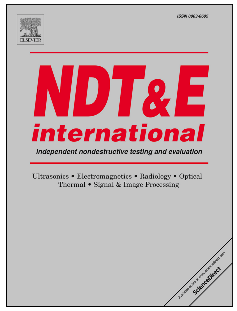

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J. Corcoran, S. Raja, P.B. Nagy

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Improved Thermoelectric Power Measurements Using a Four-Point Technique

J. Corcoran[1*], S. Raja[2], P. B. Nagy[1,2]

1. Department of Mechanical Engineering, Imperial College London, SW7 2AZ

2. Department of Aerospace Engineering and Engineering Mechanics, University of Cincinnati, OH 45221-0070, USA

* Corresponding author, joseph.corcoran07@imperial.ac.uk

Abstract

The Seebeck coefficient of a material is dependent on its composition and microstructure and is consequently sensitive to service related material degradation; of particular interest is the sensitivity to thermal and irradiation embrittlement which may be exploited for the material characterisation of in service components. Conventionally, thermoelectric measurements are taken using a two-point contact technique which introduces a temperature differential in the test component through a heated ‘hot tip’ electrode; it is argued that measurements using this methodology are sensitive to the thermal contact resistance between the component and the electrodes. An alternative three- or four-point technique is proposed where heat is introduced to the component remotely which leads to much less sensitivity to contact condition. An experiment is presented that compares the two techniques and demonstrates the improved performance of the four-point technique. Aside from the improved accuracy, the modified technique also facilitates a ‘passive’ implementation that could be used from continuous monitoring of components in service.

1. Introduction

The Seebeck effect is the development of an electromotive force (EMF) across a material in response to a temperature differential; the ratio of the EMF to the temperature difference is defined as the Seebeck coefficient, S, (Rowe, 2006). For practical, open-circuit, purposes this leads to the expression,

$$S = \frac{\Delta V}{\Delta T}, \tag{1}$$

where ΔV is potential difference and ΔT is the temperature differential across the material.

The Seebeck coefficient of a material, also known as the thermoelectric power (TEP) (Martin et al., 2010), is dependent on its composition and microstructure (Pollock, 1993). Consequently, a range of studies have established TEP measurements are sensitive to thermal and irradiation embrittlement