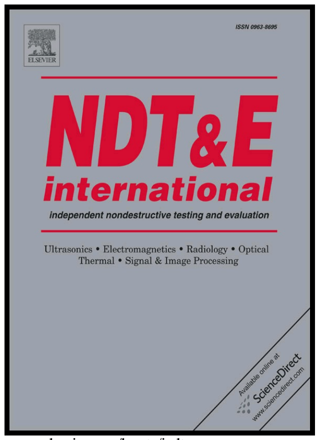


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**Abstract:** In sonic IR imaging, a major problem is exploring the heating characteristics of crack vicinity to guide the optimization of the test conditions. In this paper, the crack's heating characteristics of the metallic plate with an artificial fatigue crack has been studied. Experimental results showed that the during ultrasonic excitation the temperature rise of crack vicinity at the plate's excitation side is higher than that at its opposite side, whereas the total heating efficiency of the crack face appears to be stable. Through the profile mapping of the crack face, the frictional heating is mainly concentrated near the excitation side. Based on this phenomenon, we built a mathematical heat transfer model to calculate the temperature distribution of the crack vicinity and investigated the heating features of crack faces. Additionally, the mathematical model gives a quantitative relation between the depth of the heat source and the ratio of the temperature distribution of the crack vicinity at opposite side to that at the front side. This study aims to provide a quantitative evaluation method for locating the frictional heating areas in sonic IR imaging.

**Keywords:** sonic IR imaging; metallic plate; thickness-through fatigue crack; crack heating; heat transfer model;



## 1. Introduction

Sonic IR imaging, also known as vibrothermography and thermosonics, employs high power ultrasonic pulses to excite the test specimen resulting in heat accumulation at the defect vicinity. Then the temperature changes at the crack vicinity of the test specimen are captured by the thermal infrared imager so as to achieve the defect detection [1]. It has been widely accepted that the crack heating mainly caused by friction, plastic deformation and viscoelastic effect, of which the frictional heating take the lion's share [2,3,4]. Previous investigations have shown that during the ultrasonic excitation the temperature rises captured at crack vicinity of the plate's excitation side and opposite side have large differences.

At present, lots of work has been conducted to study the heating characteristics of fatigue crack. In 2006, Homma C. et al. experimentally verified the crack heating includes friction, viscoelastic loss and plastic deformation [2]. In 2009, Mabrouki F. et al. used MSC. Marc software