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Impact of Micro-Indentation on Hardness and Indentation Depth of Ni-Cr Super Alloys

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ABSTRACT

A material's (metal, composite, polymer, etc.) behaviour is greatly influenced by the indentation hardness and elastic modulus during any operation (sliding, fretting, turning, etc.). To measure the micro-mechanical properties of surfaces, subsurfaces and coated thin layers of materials, depth-sensing measurement indentation techniques are most commonly used. The present study aims to develop a compressive model to investigate the influence of indentation parameters on the indentation hardness and indentation depth of Ni-Cr superalloy during indentation experiments. Experiments were conducted based on model L_{18} (2^1*3^2) full factorial design with a mixed orthogonal array using a microhardness tester. The experiments revealed that indentation hardness values show a normal indentation size effect with respect to indentation load. Indentation depth values increase with the increase in indentation load. Taguchi's approach and the regression analysis were used to model the indentation hardness and indentation depth with respect to indentation parameters. Analysis of variance was employed to check the effect of input parameters on performance outputs. The experimental and predicted values show a good degree of proximity. However, indentation load (79.22% and 52.34%) was found to be the most dominant parameter affecting indentation hardness and indentation depth, respectively, followed by dwell time.

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KEYWORDS
Nickel-based superalloy; indentation hardness; Taguchi method; indentation size effect; indentation depth

1. Introduction

Micromechanical properties of solid surfaces and ultra-thin films play a significant role in a variety of applications including tribological characteristics of materials. Using indentation testers, homogenous and heterogeneous structural behaviour on and beneath the surface of a material can be evaluated, such as the presence of worn layers, graded material, grain boundaries and coated thin films [1]. Based on the indentation load–displacement curves, depth-sensing indentation (DSI) is an experimental technique used for studying the mechanical properties of materials at the microscopic scale, such as elastic modulus and microhardness [1–3]. The indentation size effect; material

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