Silicon
https://doi.org/10.1007/s12633-021-01548-9

ORIGINAL PAPER

Optimization and Prediction on the Mechanical Behavior of Granite Particle Reinforced Al6061 Matrix Composites Using Deer Hunting Optimization Based DNN

Koli Gajanan Chandrashekhar[1] · D. P. Girish[2] · Katkar Ajit Ashok[1]

Received: 26 August 2021 / Accepted: 11 November 2021

Abstract
The enhancement in the mechanical characteristics of aluminum alloy is always an essential need for the development of industrial technologies. The work presented is focused on the development of Al6061 composite reinforced with granite particles using the stir casting technique at four different proportion rates such as 2%, 4%, 6%, and 8% of granite particles. The developed composites were subjected to heat treatment as per T6 temperature conditions for different aging time durations (1 to 9 h). The mechanical characteristics such as hardness, ultimate tensile strength, and yield strength analysis are performed for both the casted and heat-treated granite reinforced aluminum specimens. Deer hunting optimization (DHO) is used to optimize the better-reinforced aluminum alloy from the heat-treated and heat untreated specimens. Besides, the hybrid deep neural network (DNN) is used to predict the experimented mechanical characteristics and compared with other similar predicted neural networks. Such optimization and prediction behavior are performed in Matlab software. From the experimentation, the hardness is better for heat-treated Al6061 reinforced with 8% of granite particles, besides the yield and the ultimate tensile strength is optimal for 6% granite reinforced Al6061. The proposed DNN-DHO provides nearer values to the experimented mechanical characteristics with minimal error than the predicted outcomes of Particle swarm optimization (PSO) based DNN and DNN alone. The DNN-DHO predicted optimal mechanical characteristics are 68.45 BHN of hardness, 199.67 MPa of ultimate tensile strength, and 100.01 MPa of yield strength. From the overall findings, heat-treated Al6061 with 6% and 8% granite offers superior mechanical properties.

Keywords Aluminium metal matrix composites · Deer Hunting optimization (DHO) · Deep neural network (DNN) · Granite · And reinforcement

1 Introduction

Aluminum alloy-based metal matrix composites are more effective in several industrial applications because of their attractive mechanical, tribological, and physical properties [1]. Most of the engine components are made up of aluminum alloys such as engine cover, connecting rods, pistons, brakes, and cylinder liners, etc. due to their lightweight and good mechanical properties. However, the alloys of aluminum are known for their softness and high wear rate, which are undesirable for many applications. Keeping their disadvantages and increasingly demanding working conditions in mind, many researchers across the world are developing aluminum alloy-based metal matrix composites [2, 3]. Lightweight reinforcements like TiB_2, TiC, TiO_2, SiC, Si_3N_4, B_4C, Al_2O_3, and carbon-based nanomaterials are used to reinforce aluminum alloys to obtain high hardness and strength [4]. Most of these reinforcements are lightweight, capable of withstanding high temperature, possess high hardness, high compressive, and tensile strength values [5]. After the addition of these various reinforcements into their respective aluminum matrices, they resulted in a significant increase in hardness and strength values. Granite particles are also efficient reinforced materials for improving the mechanical activities of Al6061 alloy [6]. This is because of its toughness behavior and ability to withstand wear

✉ Koli Gajanan Chandrashekhar
gckoli@gmail.com

[1] Department of Mechanical Engineering, Sanjeevan Engineering & Technology Institute, Panhala, MH, India

[2] Mechanical Engineering Department, Government Engineering College, Ramanagara, Karnataka, India

Published online: 15 January 2022