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Multi-objective optimization of machining factors on surface roughness, material removal rate and cutting force on end-milling using MWCNTs nano-lubricant

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Abstract

The art of nano-additive manufacturing in developing advanced mechanical components via machining cannot be over-emphasized when developing mechanical parts for aerospace, automobile, and structural application through the end-milling of aluminum alloys. However, the end-milling process generates heat and friction due to the machining parameter that initiated the contact between the cutting tool and the workpiece. This excess heat leads to high surface roughness (SR), low material removal rate (MRR), and high cutting force (CF). This study aimed to resolve the machining parameters and the material adhesion by carrying out an experimental evaluation with multi-objective optimization of the machining factors on end-milling of AL8112 alloy using copra oil-based multi-walled carbon nanotube (MWCNTs) nano-lubricant. The nano-lubricant preparation was done using the two-step method, and nano-lubricants were implemented via the minimum quantity

lubrication (MQL) method with the five machining factors. Additionally, the multi-objective optimization and prediction study was achieved using the ramp and desirability bar plot for the three responses, i.e., SR, MRR, and CF under the quadratic rotatable central composite design (QRCCD). The multi-objective optimization result shows that the minimum SR of 1.16 μm, maximum MRR of 52.1 mm^3/min, and minimum CF of 33.75 N was obtained at the optimized machining factors. Furthermore, the models predicted the experimental results accurately. In conclusion, the multi-objective optimization with copra oil-based MWCNT's-nano-lubricant enhanced machine parts' production for sustainable additive manufacturing.

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Ethics declarations

Conflicts of interest

The authors declare no conflict of interest.

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