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Optimizing the Compressive Properties of Porous Aluminum Composites by Varying Diamond Content, Space Holder Size and Content

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Abstract
The compressive properties of powder metallurgy (PM)-based porous aluminum (Al) composites were optimized at three levels based on the following parameters: titanium (Ti)-coated diamond content, polymethylmethacrylate (PMMA) particle content, and PMMA particle size. A 3 × 3 matrix was used in the experimental design of an L9 orthogonal array to get nine sets of combinations. These nine compositions were then tested and analyzed for density, porosity, plateau stress, and energy absorption capacity. The effect of individual input parameters was assessed using the Taguchi-based means ratio and analysis of variance (ANOVA). The main effect plots articulated the optimal parameter levels for achieving maximum compressive property values (plateau stress and energy absorption capacity). The findings show that diamond content and PMMA particle size have a major impact on compressive properties. The ANOVA analysis yielded similar results, with diamond content accounting for the greatest value. Further, the response optimization of compressive properties revealed that maximum values could be obtained at optimum parameters: diamond content of 12 wt.%, PMMA particle size of 150 µm, and PMMA particle content of 25 wt.%. Confirmation tests on the optimal parameters revealed improved results as well as some minor errors and deviations, indicating that the chosen parameters are critical for controlling the compressive properties of Al composites. © 2023 by the authors.

Author Keywords
energy absorption capacity; porosity; porous aluminum composite; relative density; Taguchi L9 orthogonal array plateau stress

Index Keywords
Aluminum, Aluminum coatings, Aluminum powder metallurgy, Analysis of variance (ANOVA), Diamonds, Energy absorption, Particle size, Particle size analysis; Aluminum composites, Compressive properties, Energy absorption capacity, L9 orthogonal arrays, Particles sizes, Plateau stress, Porous aluminum, Porous aluminum composite, Relative density, Taguchi l9 orthogonal array plateau stress; Porosity

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