Short communication

Institution of MECHANICAL ENGINEERS
Journal of MECHANICAL ENGINEERING SCIENCE

Proc IMechE Part C:
J Mechanical Engineering Science
1–6

DOI: 10.1177/09544062251386978
journals.sagepub.com/home/pic
Sage

Surface properties of aluminium 6061 alloy laser peened at different power densities

G. Girish[1]

Abstract

Laser shock peening (LSP) is a robust surface treatment technique widely exploited by industries of the modern era. In this study, aluminium 6061 alloy was treated with LSP at different power densities, and properties like hardness, surface roughness, microstructural evolution, and tribological behaviour were investigated. LSP applied at 3 GW/sq. cm raised the hardness and surface roughness to 97.1 HV and 0.499 μm, respectively, due to a fine-grained microstructure averaging 4.12 μm. Formation of a strain-hardened layer with dense dislocations improved the tribological performance of the LSPed specimens with minimal wear at 5 N load.

Keywords

LSP-AA6061, hardness, roughness, EBSD, tribology

Received: 17 June 2025; accepted: 25 September 2025

Introduction

Lightweight materials with improved properties are always in demand, as engineers continue to explore lighter materials for fabricating a variety of components in the automobile, marine and aerospace industries.[1] Aluminium alloys are widely preferred in particular due to their high strength-to-weight ratio, low density, excellent machinability and workability.[2,3] Compared to strain-hardenable alloys (3xxx and 5xxx alloys), age-hardenable grades (2xxx, 6xxx, and 7xxx alloys) are widely used, as the latter possess better properties due to the presence of precipitates and can be tailored using appropriate heat treatment techniques. Though they possess exceptional strength, their wear-resisting ability is low. Since wear is a surface-oriented phenomenon, the tribological performance of such aluminium alloys can be well improved by altering the microstructure on the surface without degrading their bulk properties.[3]

Laser shock peening (LSP), in recent times, is proving to be an effective low-cost surface modification technique due to its simple operation and suitability to process all classes of materials.[4] In LSP, a laser pulse at high energy is targeted onto the surface of the specimen, generating a high-pressure plasma on the surface. Upon expansion, compressive shock waves are formed, leading to plastic deformation and the formation of compressive residual stress with dense dislocations on the surface.[5] The main advantage of LSP is its low processing temperature, and the parameters can be easily altered according to the material to be processed.

AA6061-T6 is notably one of the prime grades of aluminium alloy with an outstanding strength derived from its precipitates.[4,6] But the wear performance of the alloy is relatively weak, and LSP could be potentially applied to improve its tribological properties. A detailed literature survey conducted on LSP-related studies indicated that no comprehensive tribological analysis of LSPed AA6061 was made to date.[7–9] Therefore, to fulfil a significant gap in the literature, in this study, aluminium 6061 alloy is treated by applying LSP at different laser power densities, and its resulting hardness, surface roughness, microstructural evolution, and tribological behaviour were investigated. It is to be informed that examination of residual stress and subsurface analysis were not included in this brief investigation, and related efforts will be made in future studies.

[1]Department of Mechanical Engineering, PSG Institute of Technology and Applied Research, Coimbatore, Tamil Nadu, India

Corresponding author:
G. Girish, Department of Mechanical Engineering, PSG Institute of Technology and Applied Research, Coimbatore, India.
Email: girish0889@gmail.com