Akhtar, S.S., Arif, A.F.M., Yilbas, B.S., Influence of multiple nitriding on the case hardening of H13 tool steel: experimental and numerical investigation, Int. Journal of Advanced Manufacturing Technology 58 (1-4) , pp. 57-70, 2012.

Abstract

Gas nitriding treatment is used repeatedly to re-harden AISI H13 hot extrusion die surface, which has been exposed to high temperature and abrasion by extruding aluminum alloy resulting in wearing away the existing nitrided layer. In the present work, the influence of repeated nitriding on AISI H13 steel is studied. Single, double and triple- nitrided samples, treated under controlled twostage gas nitriding process, have been included in the study to evaluate their nitrided layer morphology, hardness, case depth and quality. The nitrided layers are characterized using different techniques including optical microscopy, scanning electron microscopy (SEM), X-ray diffraction (XRD) analysis, microhardness analysis and energy dispersive spectrometry (EDS) technique. A sequentially coupled heat-diffusion analysis of re-nitriding treatment is also conducted numerically using finite element code, ABAQUS. The numerically predicted results are in close agreement with experimental results in terms of nitrided layer growth and nitrogen concentration distribution in the diffusion zone. The results reveal that multiple nitriding treatment on H13 steel has significant effect on compound layer thickness and its phases, hardness-depth profile, and nitrided case depth. It was found that excessive cumulative nitriding time during multiple nitriding treatment results in greater nitrided depth and significant increase in hardness with deeper affect due to dense and deeper precipitation of nitrides in the nitrided layer. Multiple-nitrided samples show oxidation and porosity in the near-surface part of nitrided layer due to the interaction of iron with oxygen of the air upon decomposition of iron nitrides in the compound layer during re-nitriding. This results in reduced hardness in the near-surface part of the nitrided layers.