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Deformation behavior of directional die surface textures in warm and hot working

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It has long been recognized that die surface roughness and lay have significant effects on flow behavior in sheet metal forming processes. In comparison, relatively little research has been conducted to explore similar effects in bulk forming processes. In the present paper, an experimental study was conducted using warm and hot working conditions to investigate how directional (anisotropic) tool topography on friction and planar flow. The study was conducted using lubricated AISI H-13 steel platens which had unidirectional finishes on the working surfaces. Six sets of tools with different surface roughnesses were used to compress 6061-T6 Aluminum and AISI 1018 steel specimens which had an isotropic surface finish. Ring tests were used to measure and compare friction parallel and perpendicular to the platen lay for each experimental condition. Prismatic pieces were side pressed at different angular orientations to study changes in planar flow behavior. In contrast to sheet forming, friction factors parallel to the lay were lower than those in the perpendicular direction though this effect depends on the type of lubricant. Increased flow stress and the resulting decrease in asperity penetration were also found to affect friction differences in the directions parallel and perpendicular to the lay. Based on calculated spread ratios, die surface roughness and workpiece orientation were both found to have an effect on planar metal flow though this effect is also modified by lubricant type and process conditions.

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