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Deformation mechanisms in advanced Ti-based alloy in instrument-workpiece interaction

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Summary

Industrial applications of Ti-based alloys especially in aerospace, marine and offshore industries have grown significantly over the years primarily due to their high strength, light weight as well as excellent temperature- and corrosion-resistance properties. Since these alloys are hard to machine, there is an obvious demand to develop simulation tools in order to analyze the material's behavior in machining processes, such as a turning, and to optimize process parameters. High levels of strains and strain rates accompanied by generated high temperatures characterize the deformation process in turning. The character of realisation of deformation mechanisms as well as a spatial distribution of their parameters in turning has some similar features with other tool-workpiece interaction processes under certain conditions. One example is dynamic indentation, in which an indenter penetrates into a workpiece. Comparison of a dynamic indentation technique with quasi-static one enables us to measure time-resolved depth and load responses. Hence, it can serve as a tool for understanding the spatio-temporal realization of deformation mechanisms in Ti-based alloy. In parallel with studies of the macroscopic (global) response of the material to indentation, micro-indentation is also studied to elucidate the effect of crystallographic texture on the material's behaviour at micro-scale. This study, based on combination of various experimental techniques with finite-element simulations of instrument-workpiece interaction, provides a comparative analysis of characteristic features of deformation processes at micro and macro scales in Ti-based alloy and investigates the effect of various factors on their realization.