SPATIALLY RESOLVED STRAIN MEASUREMENTS ON MICRO MOULDS

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Advanced production technologies for micro components, such as micro powder injection molding, require the fabrication of precise and reliable micro molds. Such molds are frequently fabricated from polycrystalline alloys by micro milling. The residual stresses introduced by the fabrication process may affect the dimensional stability and the lifetime of the molds under the cyclic thermal and mechanical loads imposed during service. The quantification of the residual stresses in such micro molds is essential for reliability considerations. It is, however, a challenging task to analyze these stresses experimentally on the relevant micrometer length scale.

The present study is conducted within the scope of the Deutsche Forschungsgemeinschaft (DFG) Collaborative Research Centre 499, "Development, production and quality assurance of molded micro components made out of metallic and ceramic materials". Steel micro moulds produced by micro milling of previously ground surfaces were investigated in the as-ground, as-milled and post treated (by micro peening) states, using the synchrotron X-ray diffraction set-up MAXIM available at the G3 beamline of HASYLAB - DESY Hamburg Germany. The MAXIM set-up has a spatial resolution of 13 μm which ensures that the strains laterally distributed over the micro mold specimen are measured in great detail. Our results show that micro milling significantly alters the surface-near residual stress state. Peening of the as-milled surface using a variety of shot materials (such as silicon carbide, corundum and glass) in the size range of 10 - 20 μm, leads to compressive residual stresses in the order of about 850 MPa. The trace marks created by the milling tool vanish due to the peening and residual stresses are homogenously distributed over the impacted surface.

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