RESIDUAL STRESS DETERMINATION IN SURFACE TREATED ALUMINA SAMPLES APPLYING BEAM LIMITING MASKS

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Determining residual stresses by diffraction techniques is a widely used method. Conventional Laplace methods thereby determine mean stress values within the X-ray penetration depth τ. In case of small variations of the residual stresses over τ, the discrepancies between real space stresses $\sigma(z)$ and the measured ones $\sigma(\tau)$ are negligible. This assumption usually does not hold when determining stress in depth distributions of surface treated alumina samples where steep stress gradients can often be observed.

The use of highly absorbing beam limiting masks can be a suitable way to overcome these problems as long as in the irradiated volume, defined by the mask design, no significant change of the residual stress state occurs. The idea for such masks was theoretically described by Predecki in 1993. The practical implementation discussed in this paper led to the conceptual design of one mask for each measurement depth and tilt angle ψ. During the assembly of the masks, accurate aligned slit structures were written by UV lithography on a polyimide film bonded on a silicon wafer. The absorbing layer was deposited by a subsequent gold galvanic process. Image series taken with a position sensitive CCD-camera, equipped with a multi channel plate for 2-dimensional beam collimation, demonstrate that the procedure is able to detect interferences from gauge volumes beneath the sample surface for defined slit geometries. These images clearly show the slit structure of the masks by crystallites which fulfil Bragg condition. Due to the highly absorbing masks the amount of detectable photons is poor and thus long exposure times are necessary to receive suitable data. For increasing measurement depths (altering masks) a decrease of intensity can be detected which leads to the assumption that the diffracted photos derive from deeper regions in the material.

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