Title: Investigation of titanium alloys using neutron diffraction

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Abstract: Titanium grade 2 was treated by multiple passes of the continuous equal-channel angular pressing technique (CONFORM ECAP) and, after each pass, additionally by rotary swaging. The residual strain field in samples processed by only CONFORM ECAP was studied by neutron diffraction strain scanning. In order to elucidate the microscopic background and calculate the related residual stress field, the local microstructure was thoroughly investigated by various experimental techniques. The microstructure and the deformation behavior of the rotary swaged samples was studied by transmission electron microscopy and by in-situ neutron diffraction during compression.

The results of the analyses indicated that microstructural gradients were present in the material as the result of the inhomogeneous deformation during the CONFORM ECAP treatment. These gradients were identified as the main reason of the presence of residual stress fields. The distributions of stress fields calculated based on microstructural parameters were in correlation with simulation results. The additional rotary swaging treatment resulted in a nanocrystalline grain structure with increasing homogeneity as the number of previous CONFORM ECAP passes increased. Deformation twinning was identified as a major deformation mechanism whose role was gradually reduced by the decreasing overall grain size.

Keywords: Titanium, severe plastic deformation (SPD), residual stresses, neutron diffraction, deformation twinning