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A structural tensor-based modelling approach to capture symmetry group evolution in anisotropic finite strain plasticity

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In 1997, Kim and Yin experimentally analysed the yielding behaviour of cold rolled sheet metal that is subjected to finite plastic deformations. Their findings, published in [1], suggest that the principal structure of the initially orthotropic-type yield function is maintained throughout the deformation process. However, a rotation of the principal material directions is observable. Being more precise and formulating the latter observation in mathematical terms, the eigen-directions of the structural tensor, which may be used to characterise the yield function's symmetry group, seem to align with the principal loading directions. If one assumes that the anisotropic yielding behaviour is induced by the crystallographic structure itself, this effect would correspond to a (local) reorientation of the crystals and hence to an evolution of the anisotropy that was induced by the rolling process. Motivated by the experimental findings, a specific model is elaborated, which is based on the fundamental theoretical developments by Lu and Papadopoulos in the context of evolving material symmetries in finite strain plasticity, see [2, 3]. We propose specific evolution equations for the structural tensors which are treated as internal variables and use a finite element-based implementation to show that the proposed modelling approach is capable of reproducing the experimental findings.

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