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Investigation of texture evolution during rolling process of non-oriented Si based electrical steels with 2D and 3D RVEs

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The process chain of non-oriented silicon based electrical steels consists of continuous casting, hot rolling with considerate heat treatment followed by cold rolling and final heat treatment. Every step in this process chain has an influence on the microstructure development like texture and grain size, which in turn influence the desired electromagnetic properties (low iron losses and good magnetic flux densities). Texture evolution during cold rolling plays a major role on the recrystallization (RX) characteristics (RX texture and grain growth) in the final heat treatment. To optimize the texture evolution in cold rolling in order to obtain better electromagnetic properties a verified simulation model is necessary. For this purpose, hot band strips are cold rolled in three consecutive passes for 50 % height reduction. After each pass macro texture was measured to evaluate the texture evolution. This multi pass rolling process is simulated in a top-down multiscale modelling approach where elasto-plastic based FEM simulations of cold rolling are performed to obtain the history of the deformation gradient at the centre of the workpiece. This history variable is then imposed on a polycrystal Representative Volume Element (RVE) using a phenomenological Crystal Plasticity FEM (CPFEM) material model developed in DAMASK crystal plasticity tool [1]. The influence of the RVE dimension on the predicted texture evolution is analysed by the comparison of a 2D RVE simulation [2] to a 3D RVE simulation. Thereafter, the fibre texture intensities from both models are compared with the experimental results. The 3D RVE is able to predict the experimentally measured texture evolution more precisely and thus overcoming the limitation of a 2D RVE.

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