

On the identifiability of the slip system interaction matrix from residual topography left by nanoindentation in Nickel

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Pile-up distribution around residual imprint of indentation on single crystals is known to be greatly influenced by the indented crystallographic orientation but also by the shape of the indenter [1]. Numerous authors have shown that it is possible to reproduce numerically this pile-up distribution using material's behaviour law based on crystal plasticity or dislocation dynamics [2, 3]. But the opposite way, i.e to identify the complete material law from the experimental topography, is not so easy. In this way, we report numerical and experimental results of nanoindentation at grain scale in case FCC material. Two polycrystalline nickel samples were studied: an annealed sample and a work-hardened one, both with large grains (characteristic size about 140 μm and 168 μm , respectively). Piles-up and slip traces were systematically analysed for Berkovich indentations performed along the four crystallographic directions [001], [101], [111] and [123], and with different orientation of the Berkovich indenter in a given indentation plane. Indentation imprints were examined by atomic force microscopy in order to measure piles-up size and geometry and to identify the activated slip systems. The indentation test has been modelled with the FE code Zebulon under the single crystal plasticity framework, using the Meric-Cailletaud model [4]. These results reveal that, pile-up sizes and shapes are strongly dependant of the hardening matrix of the single crystal plasticity model which is related to the interactions between the different slip systems, but also suggest, that a part of the components of this matrix is identifiable from the measure of the residual topography.

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