Mechanical characterization of pentagonal silver nanowires inside a scanning electron microscope and simulation of mechanical properties

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Silver (Ag) is a promissing material due to its superb electical and thermal conductivity and its potential in nanoscale applications should not be ignored. Silver, in form of 1D nanostructures or nanowires (NW), has many potential applications in nanoelectromechanical systems, where the physical properties as well as the perfect structure and ease of manufacturing are key parameters. In many of such applications, like in nanoswitches or nanoresonators, the NW must withstand many repetitive movements. From this point of view, the deeper understanding of elasticity, plasticity, fatigue and fracture mechanics of Ag NWs is of great importance for improving the preformance and reliapility of such NEMS systems.

In this study the in situ mechanical characterization of Ag NWs inside a scanning electron microscope using the cantilevered beam bending technique is demonstrated. Measurements consisted of the controlled bending of the cantilevered NW by the tip of a atomic force microscope glued to the force sensor. The finite element method was used to simulate the experimental conditions to gather further knowledge about the stress and elastic energy distribution in the NW during bending. A novel model was developed for the simulations which takes account the pentagonal cross-section and the anisotropy of the Ag NW. Internal stresses in the Ag NW due to its fivefold twinned pentagonal structure were also visualised by closing the intrinsic angular gap of the Ag NW's structure in the model.