ESRF	**Experiment title:** **Mechanical properties of single Fe nanowires studied by in situ three-points bending tests combined with µLaue diffraction**	**Experiment number**: 32-02 805
Beamline: BM32	**Date of experiment**: from: 23/11/2017 to: 28/11/2017	**Date of report**: 09/03/2018
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Objective & expected results (less than 10 lines):

The goal of this experiment was the study of the nano-mechancical properties of single BCC Fe nanowires by in situ three-point bending tests combining the in situ AFM "SFINX" and Laue microdiffraction. While the mechanical behvior of FCC nanostructures are well invetigated, works on BCC nano-objects are scarce.

Results and the conclusions of the study (main part):

Iron nanowires with a diameter of 100 to 200 nm and a length of up to 10 µm were grown by vapor phase deposition on carbon coated tungsten substrates. Individual nanowires were harvested and placed across 2 µm wide Si micro-trenches using micro-manipulators in a scanning electron microscope, thus forming suspended nano-bridges. The nanowires were thoroughly attached at both ends by electron beam induced deposition of Pt using a precursor gas in a SEM. A scanning electron micrograph of such a Fe nanowires is presented in Fig. 1(c). For the intended in situ three-point bending experiments, SFINX was installed at the BM32 beamline. The nanowires were located by measuring the yield of the Fe-Kalpha fluorescence.

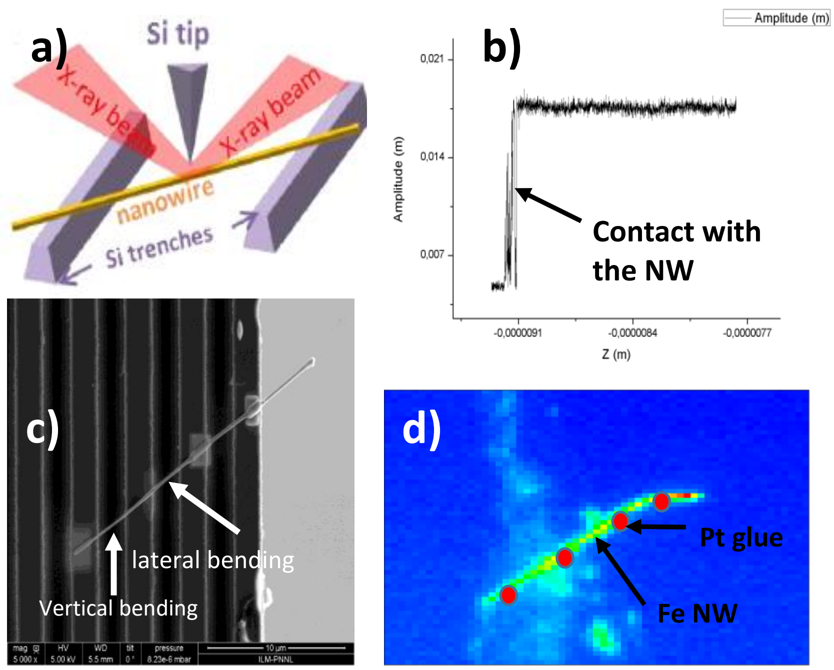

Fig. 1: a) Schematic of the *in situ* mechanical and µLaue measurements.
b) Approach-retract curve of the AFM.
c) Scanning electron micrograph of a suspended Fe nanowire glued by Pt deposition.
d) Fluorescence map of a suspended and glued Fe nanowire.

During mechanical loading with the AFM-tip Laue microdiffraction patterns were recorded. At pre-defined loads, the complete profile of the mechanically deformed nanowire was measured by scanning the focused X-ray beam along the nanowire using the KB scanning method.

We deformed the nanowire by two different ways, vertical and lateral bending with the AFM tip. The first vertical bending was made between the first two trenches, the lateral one was made between the second and third trenches (see Fig 1(c)).

Integrated Laue microdiffraction patterns of the same Fe Laue spot for a nanowire at different loading stages is presented in Fig. 2 (a) and (b)

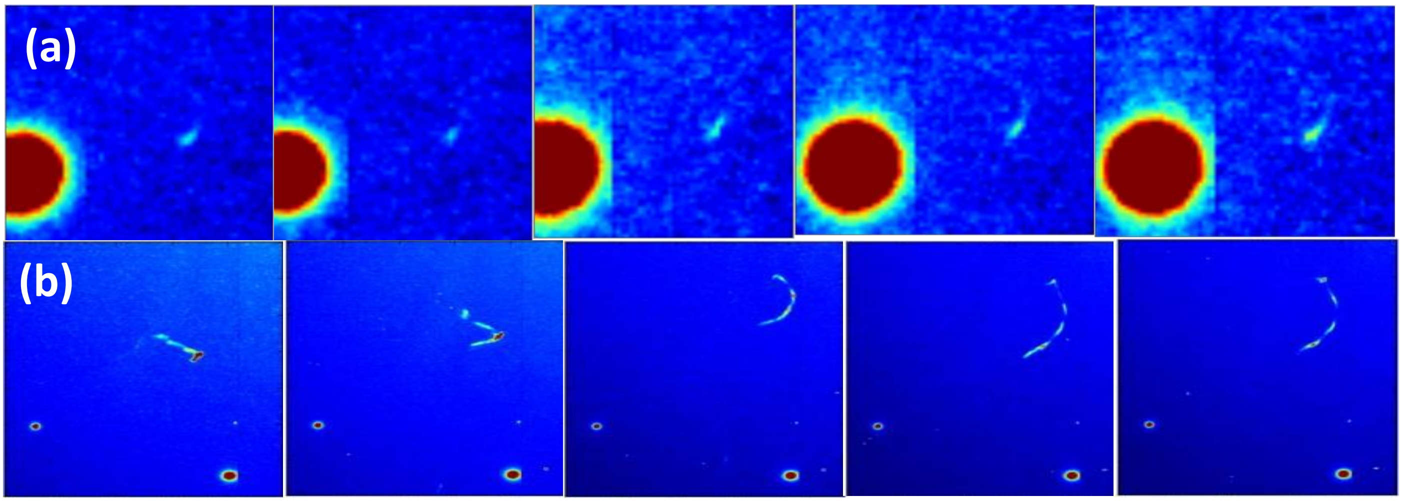

Fig. 2: Image sequence of a Fe and a Si Laue spots during loading with the AFM-tip, (a) vertical bending and (b) lateral bending

In addition to the intended in situ three-point bending test on Fe nanowires, we performed in situ nano-indentation experiments on individual Au crystals using the same setup as before. The Au crystals were prepared by dewetting a 45 nm thin magnetron sputtered Au film on a sapphire substrate. Laue microdiffraction evidenced that some of the Au crystals contain a twin boundary parallel to the crystal-substrate interface (see Fig. 3(a,b)). In situ nano-indentation revealed that the Au crystals containing a twin boundary exhibit a lower maximal sustainable load before massive plastic deformation occurred (see Fig. 3(c)).

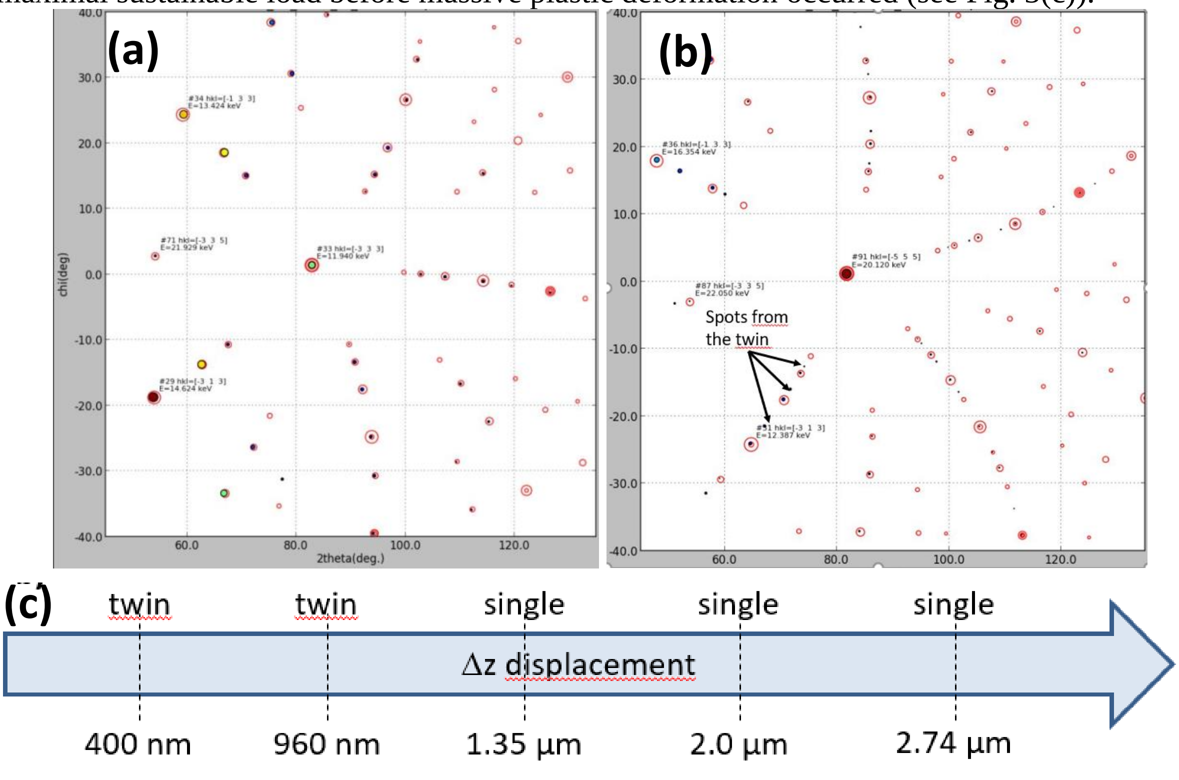

Fig. 3: indexation of an Au nanocrystal, (a) without twin, (b) with a twin, (c) ΔZ piezo displacement reached before major plasticity event for Au nanocrystals with and without twin.