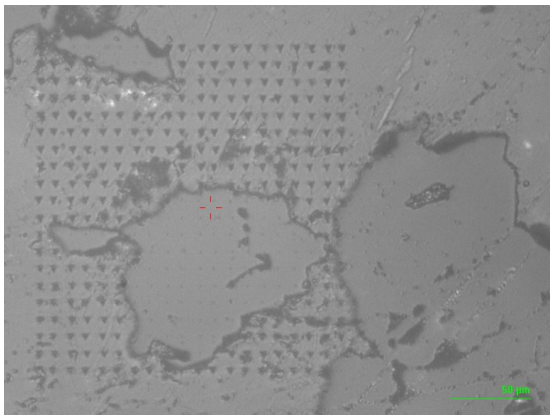
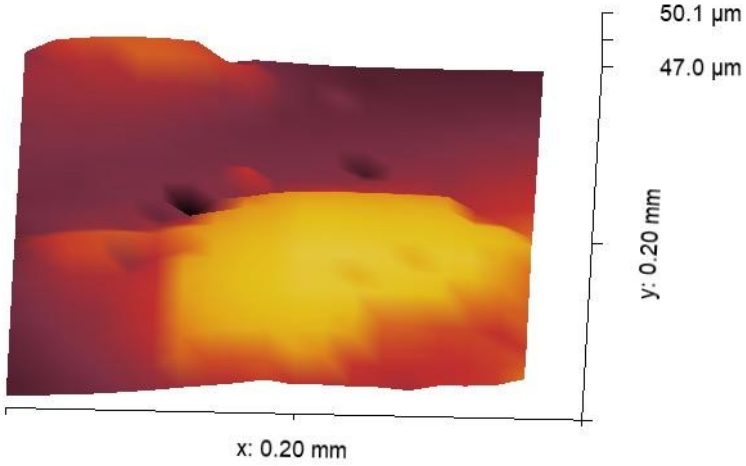
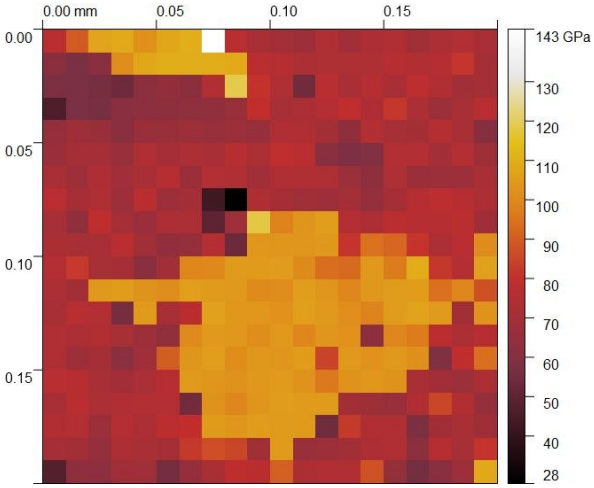
# Mapping of mechanical properties



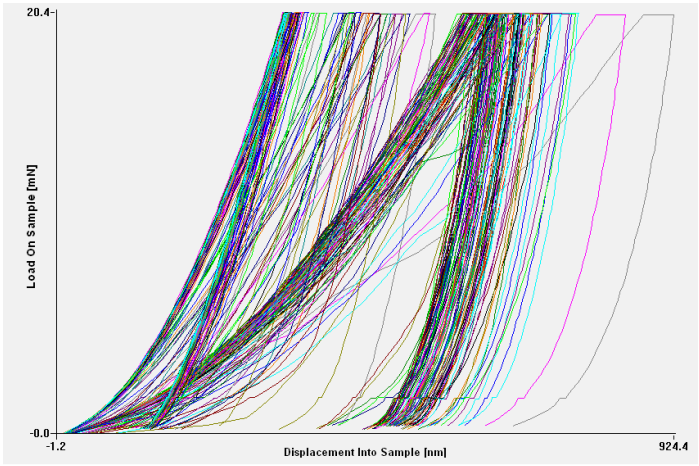
Indents to 20 mN of load in silicate rock with a height (hardness) contrast. Smaller indentation marks are due to the increased hardness on the “islands”.



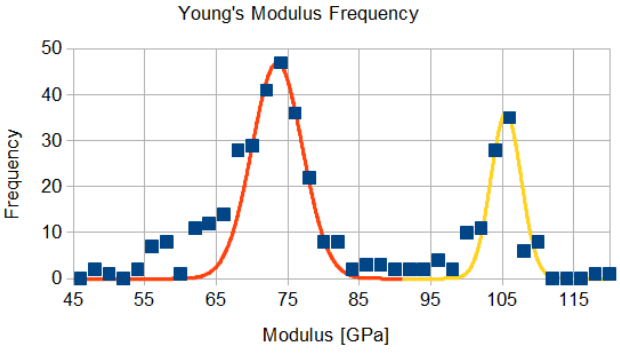

Height of the indenter to surface contact plotted with Gwyddion. The height differences are a result of the polishing process.




Mapping the elastic modulus shows a distribution, which correlates with the optical observations.




Low cycle time testing allows to study and to compare the indentation curves for all indents. The two groups of curves show the two hardness levels within the mapped sample region.




Gauss shaped peak fitting of indentation data is used to extract representative values for heterogeneous samples.

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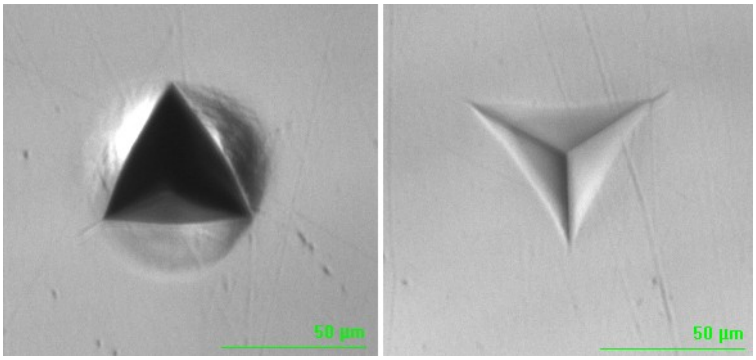
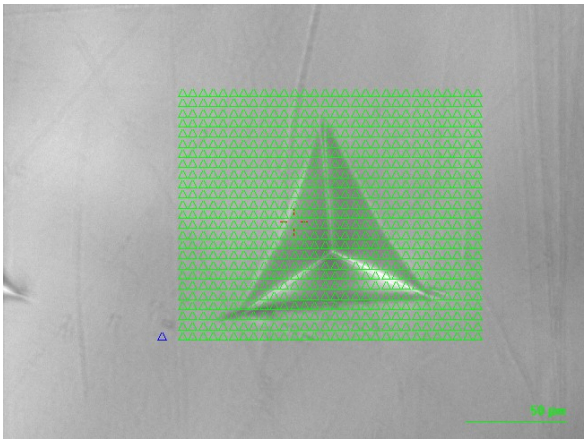
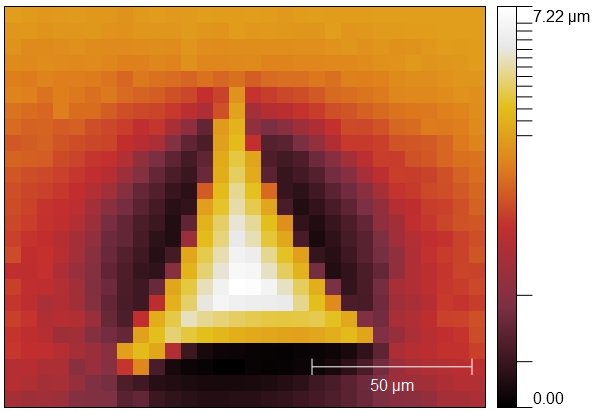
## Using mapping data to study surface deformation

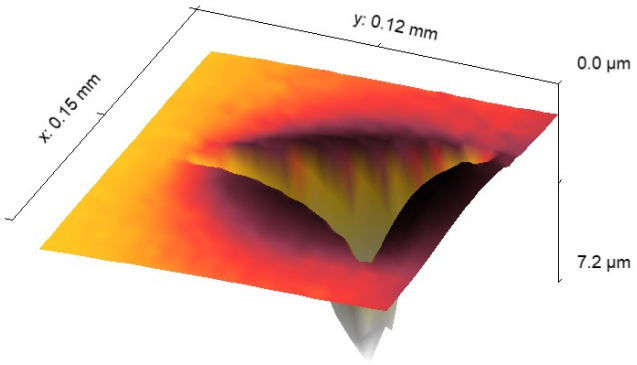



The optical microscope image (left) shows indentation marks in a polymer (SAN) surface from cubecorner and Berkovich shaped indenters. The pile-up around the cubecorner imprint is very pronounced, creating a 3d-impression in the incident light microscope. The region around the Berkovich type imprint appears flat in this image.






In order to study the topography of the Berkovich imprint, an array of 30x25 indents with a spacing of 5 µm was placed on the imprint. We used a cubecorner tip for best imaging and limited the indentation load after surface detection to 50 µN.




Plot of the topography obtained from surface detection height using Gwyddion. It can be visualized, using the nonlinear color scale, that the deformation extends much further than visible in the optical image.

### Technical Note:

Sm@rt mapping uses fast cycle indentation tests, which can be parameterized over the full range of forces or displacements. Mapping spacing and sizes are not restricted as the normal stage is used for positioning. The indenter to sample distance is approx. 50 µm during stage travel, which enables large areas to be investigated.

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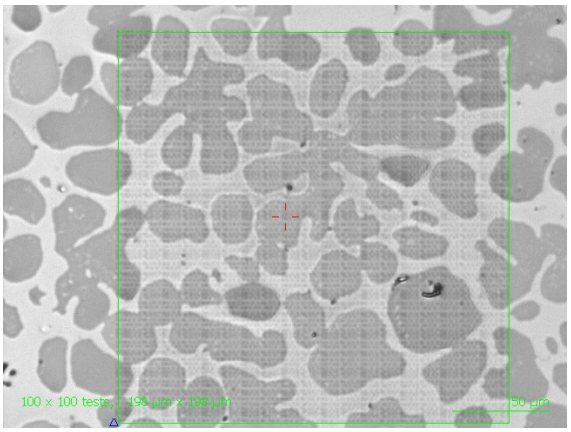
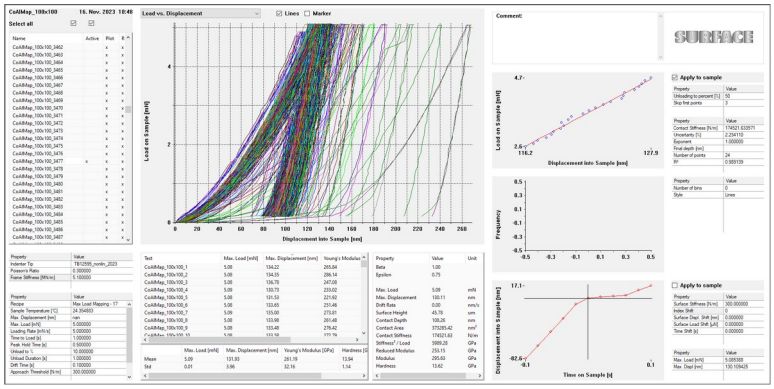
# Application note

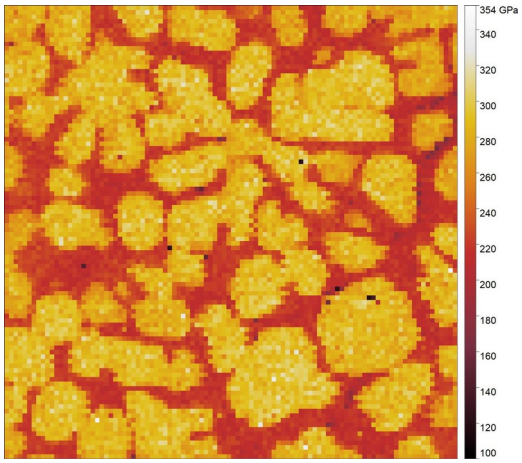
## Large map on Co - 60 Al two phase alloy, annealed 900°C 3 weeks



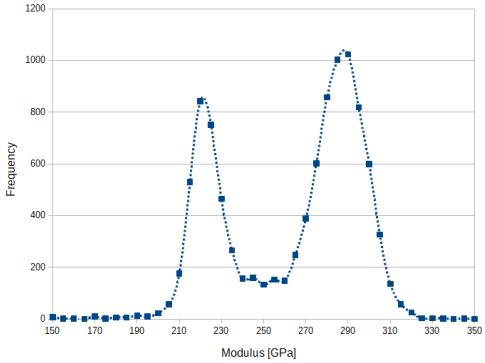

Co-Al intermetallic phases visible in optical microscopy image of the polished surface. Green overlay: 200x200 µm with 100x100 indents.

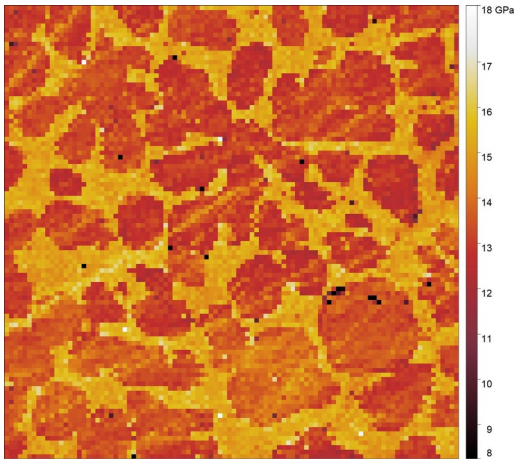


Results indicated in software with 10000 load-displacement curves showing full set of data.




Mapping the elastic modulus shows two separate phases corresponding to optics. Histogram plotted below.




Reversed contrast for hardness of the phases. Hardness varies also due to scratches, contaminations, imperfections.

Sample prepared by Frank Stein, Max-Planck-Institut für Eisen-forschung, Düsseldorf provided by Steffen Brinckmann, Forschungs-zentrum Jülich GmbH

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