Characterization of steel: MFM and KPFM

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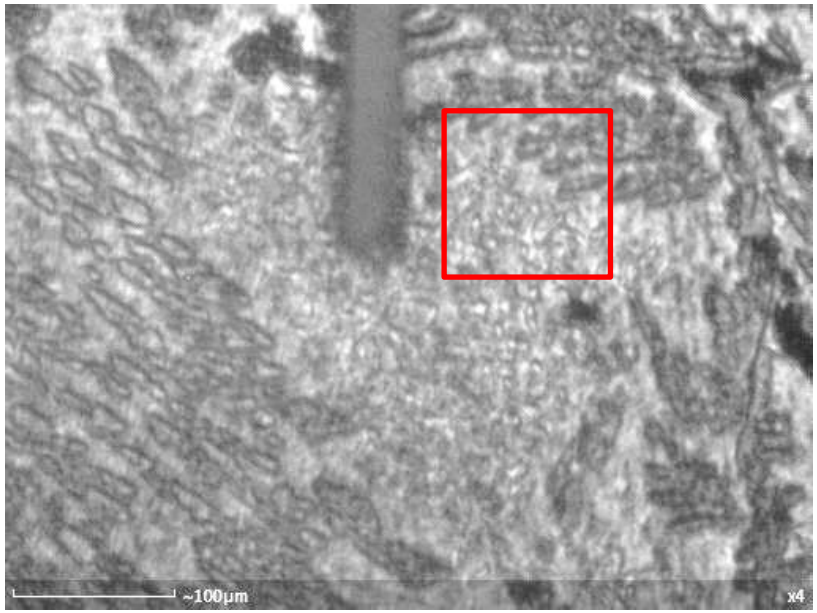
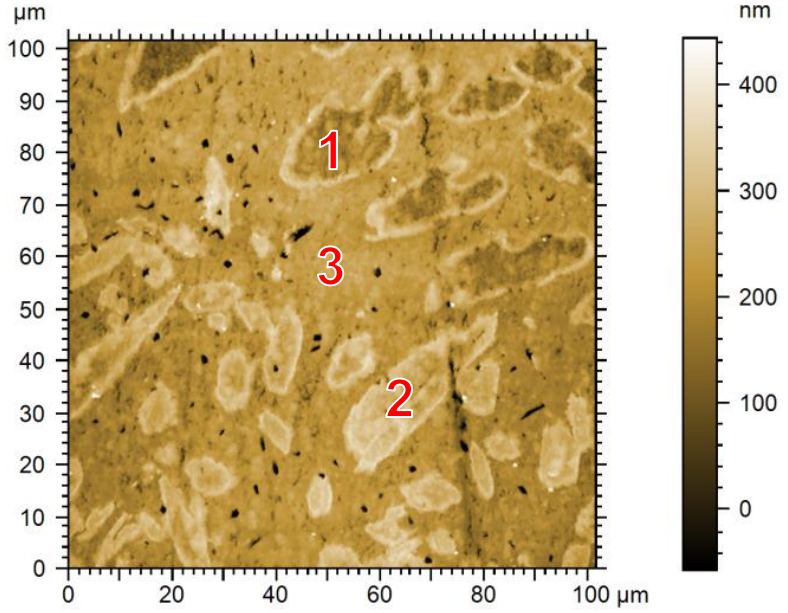
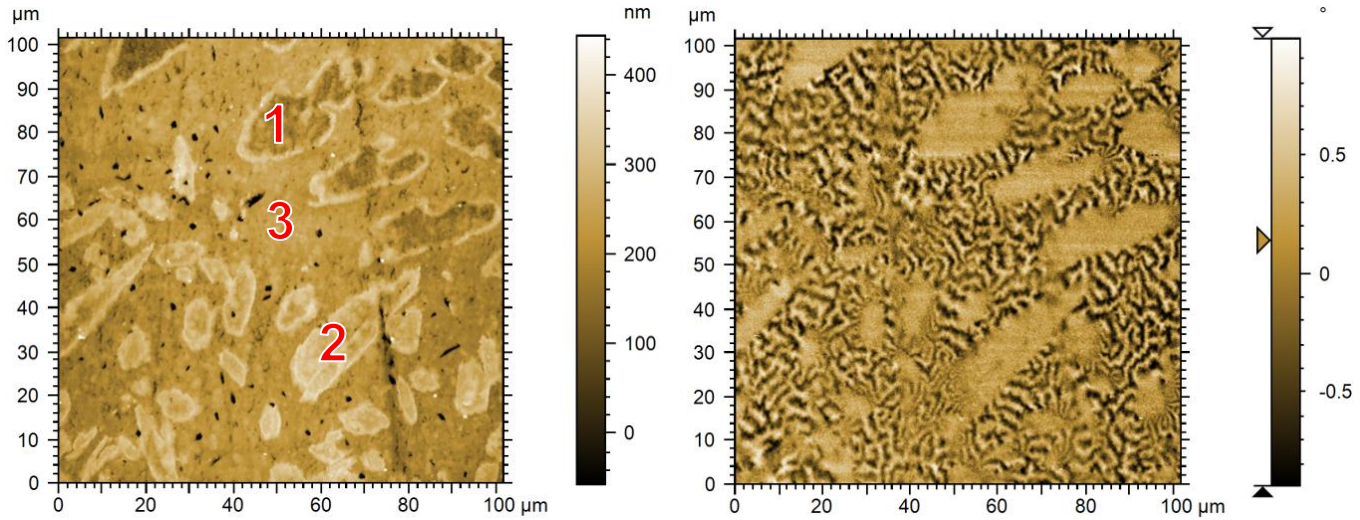
Characterization of steel: MFM and KPFM

- Standard practice: Make steel phases visible by polishing and (electro)chemical etching of the sample. Visible are dark and bright inclusions in a matrix.
  What can we learn by AFM?
- Dark areas are low (1) and bright high (2) inclusions in a matrix (3).
  Are these different materials?





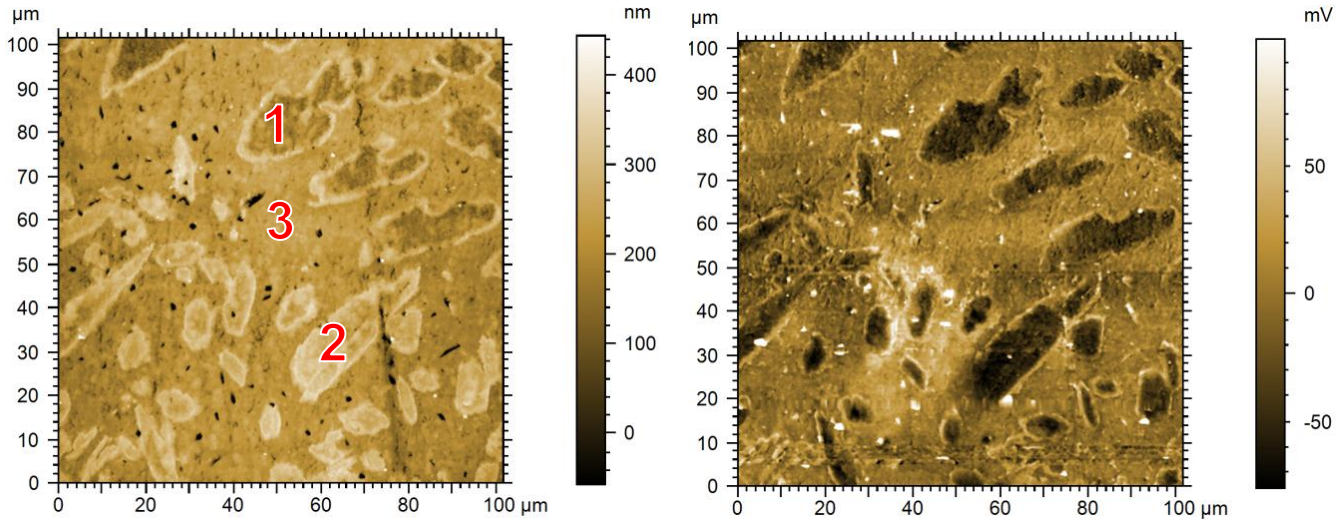
Characterization of steel: MFM



- Both the low (1) and the high (2) inclusions do not have domains, the matrix (3) does have magnetic domains

  →The matrix is the magnetic ferrite phase

Characterization of steel: KPFM



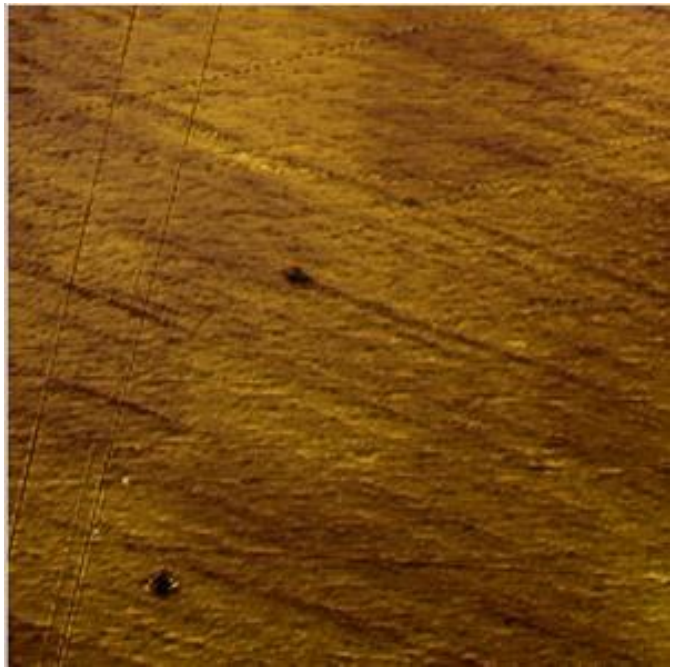
- The low (1) and (2) the high areas have a 60mV lower contact potential than the matrix (3)

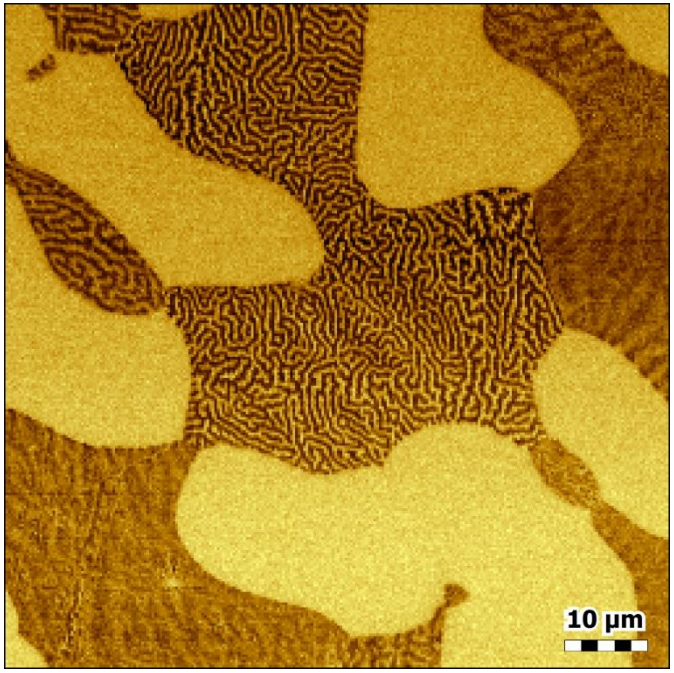
  →60mV lower contact potential difference → 60mV higher work function of the inclusions

  →different appearance in optical microscopy due to sample preparation, not due to differences in the material

MFM and topography on a different sample

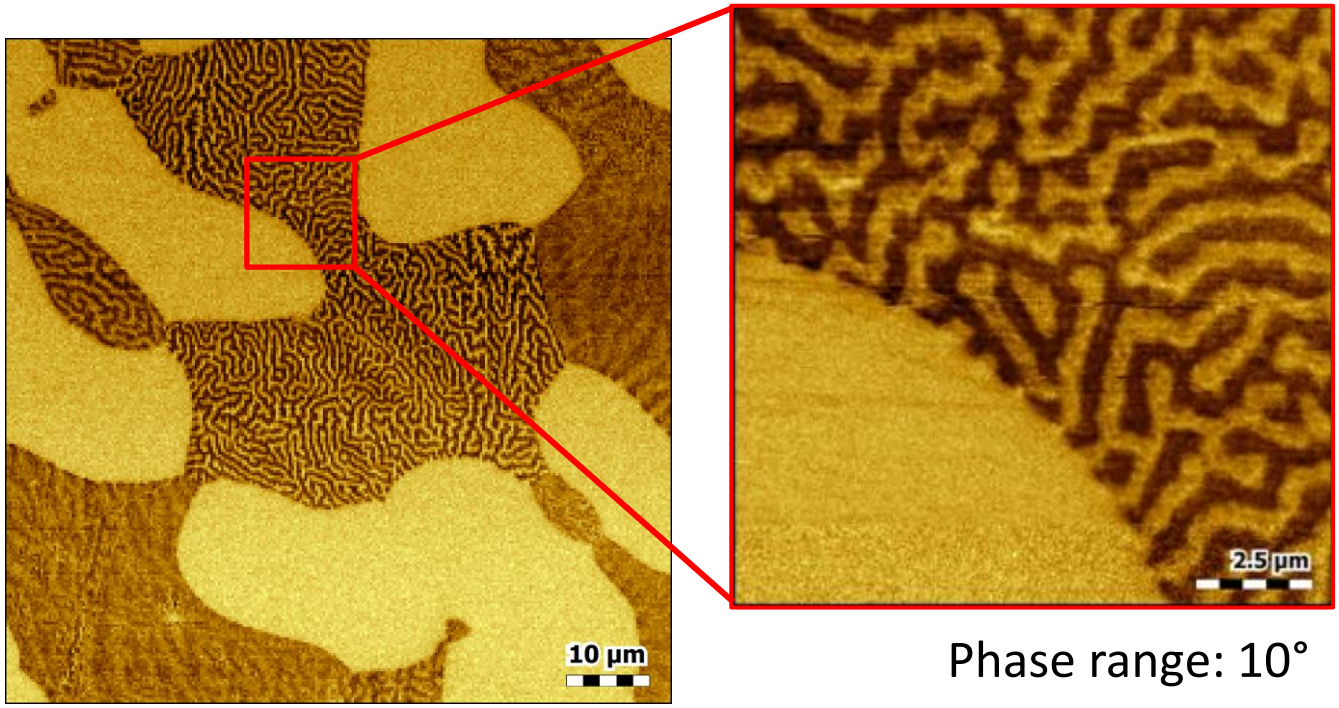
- Due to different polishing the height difference between inclusions and matrix is smaller
- The matrix shows grains with magnetic domains of different period and contrast. This is due to the crystal orientation of the grains, and the resulting variation in the easy magnetization axis





MFM of stainless steel

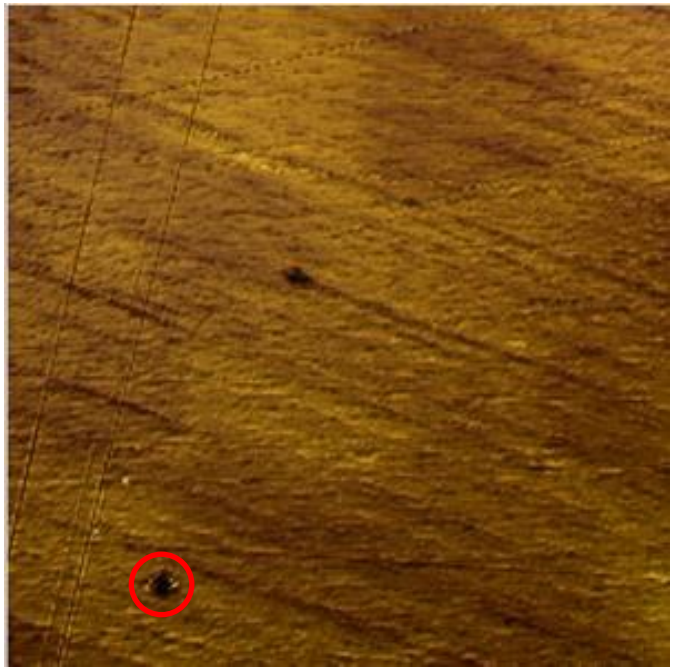
The period of the maze like structure in a grain is relatively homogeneous as also visible in the zoomed in area

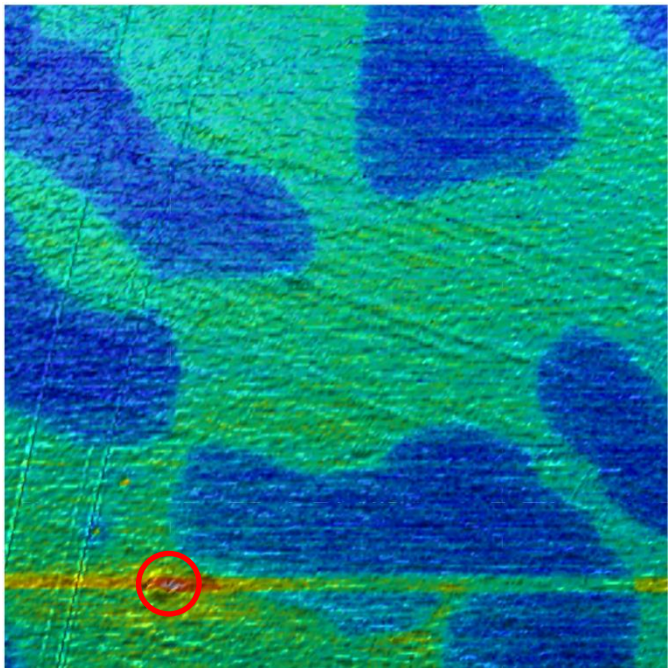


Phase range: 10°

Topography and KPFM of the same area

- Overlay of surface contact potential in color on topography.
- The defect causes a tip modification resulting in a potential step across the complete scan line





Potential difference on this sample: 80mV