



The Surface Structure and Magnetic Properties of Fe-Al alloys

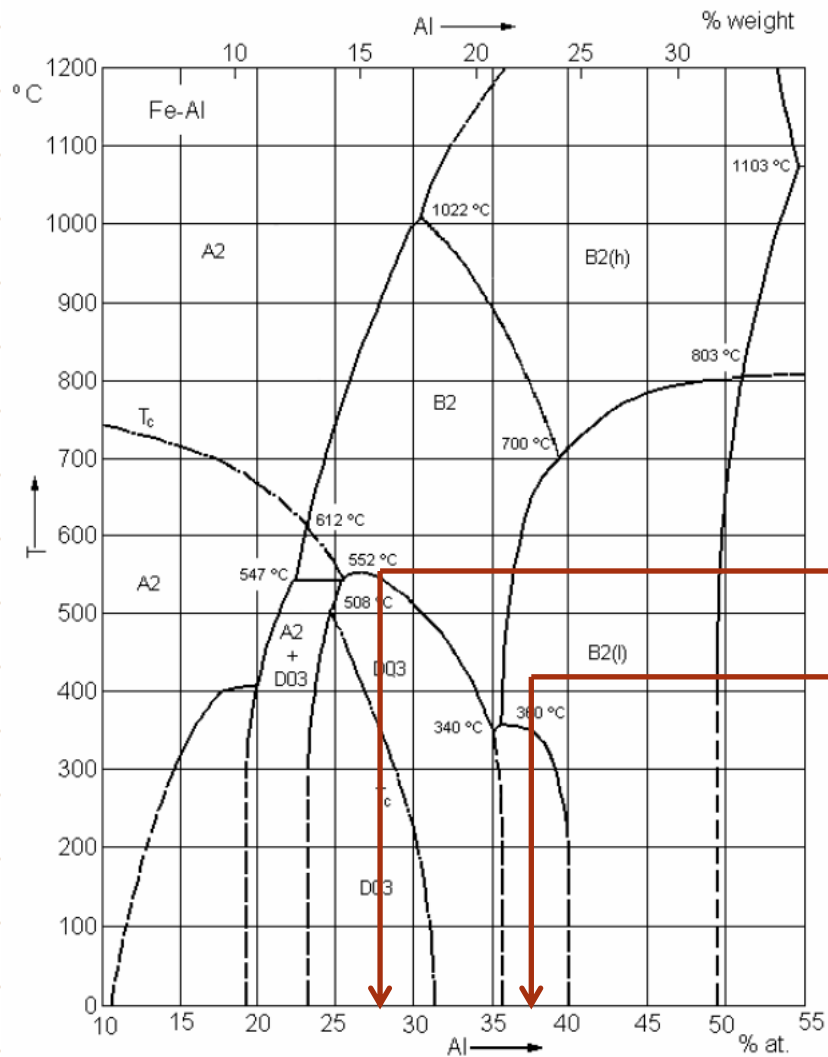
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Outline

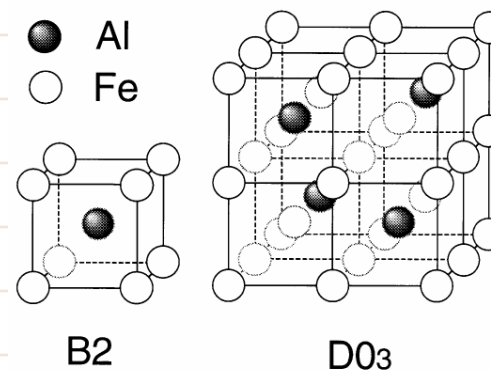
- Material specification (Fe-Al-based alloys)
- Experimental techniques involved in investigation
 - Surface-sensitive methods
 - Volume-sensitive methods
 - Supplement methods
- Results
 - Volume magnetic properties (hysteresis loops)
 - Surface magnetic properties (hysteresis loops and domain observations)
 - AFM/MFM (topography and magnetic contrast)
- Conclusion

Fe-Al based alloys



Preparation:

- from pure Fe and Al elements by induction arc melting in Ar atmosphere
- ingots were cut into the round samples (10 mm in diameter, thickness of 500 μm)
- final fabrication of the surface – grinding and polishing up to mirror-like surface
- Three different composition
 - $\text{Fe}_{72}\text{Al}_{28}$ (assumed phase - A2, D03)
 - $\text{Fe}_{67}\text{Al}_{33}$ (assumed phase - B2, D03)
 - $\text{Fe}_{65}\text{Al}_{35}$ (assumed phase - B2, D03)



Iron binary phase diagrams - Berlin: Springer-Verlag, 1982.

Experimental techniques

- Volume magnetic studies:
 - Vibrational sample magnetometer (VSM) – MicroSense
 - hysteresis loop measurement



Experimental techniques

- Surface magnetic studies:

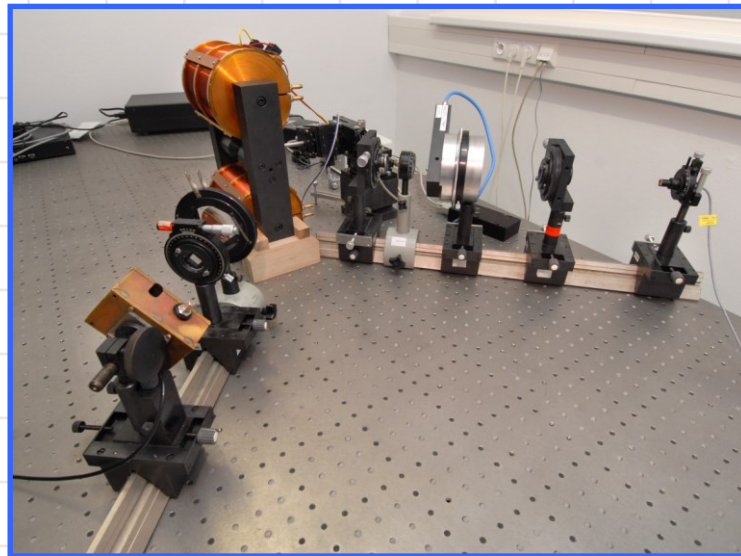
Magneto-optical Kerr effect (MOKE)

Scanning probe microscopy (AFM/MFM)

- topography and magnetic contrast

- domain observations

- hysteresis loops measurement

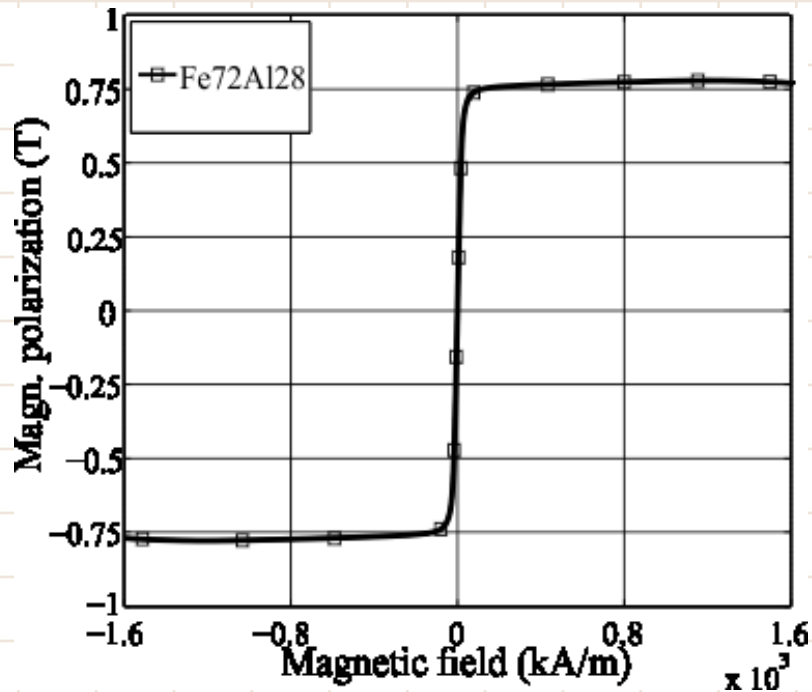
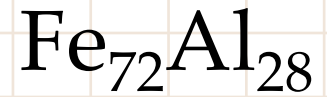


Magneto-optical Kerr microscopy
(Carl Zeiss)

Differential vector magnetometry

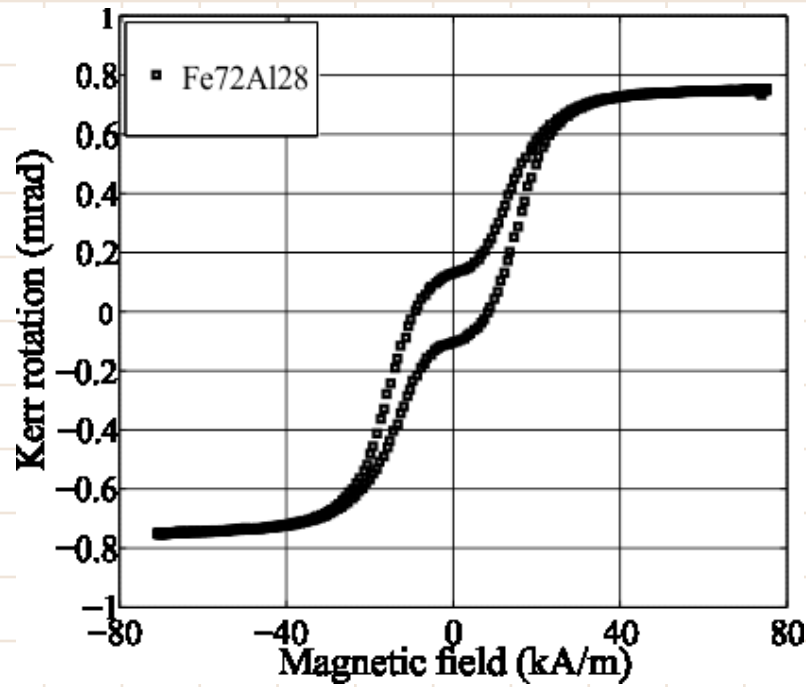
NtegraPrima platform (NT-MDT)

Results



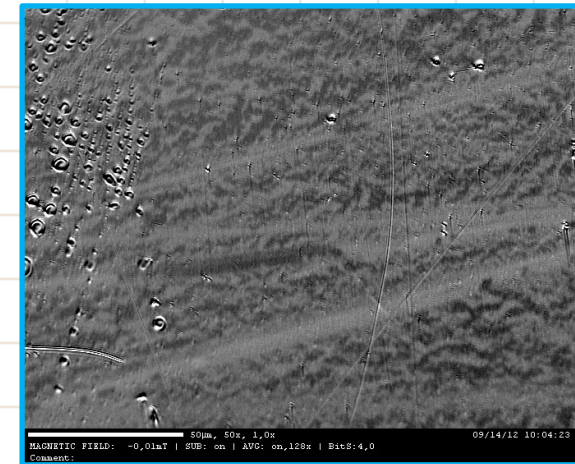
VSM volume hysteresis loop

Coercitive fields 0,06 kA/m (VSM)



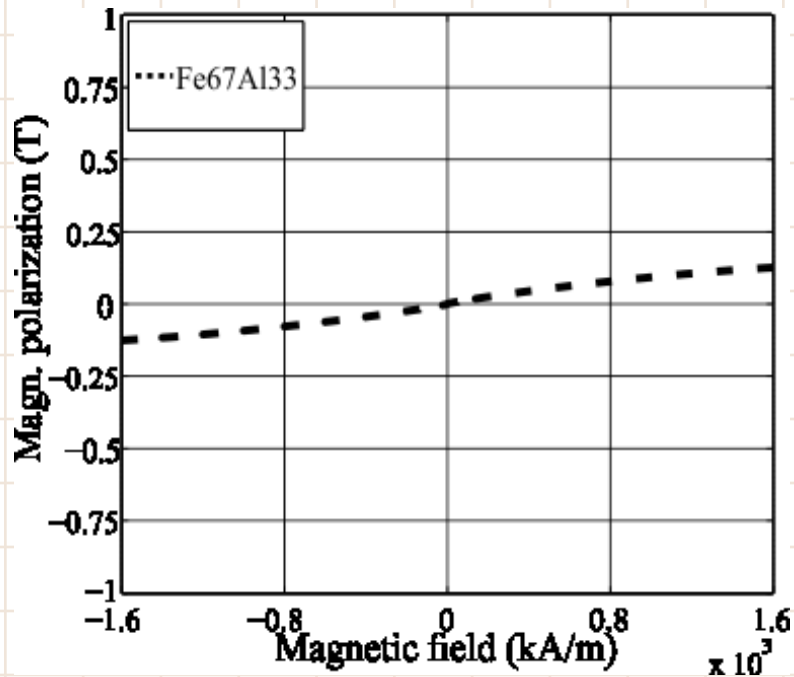
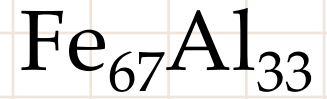
MOKE surface hysteresis loop

8,8 kA/m (MOKE)

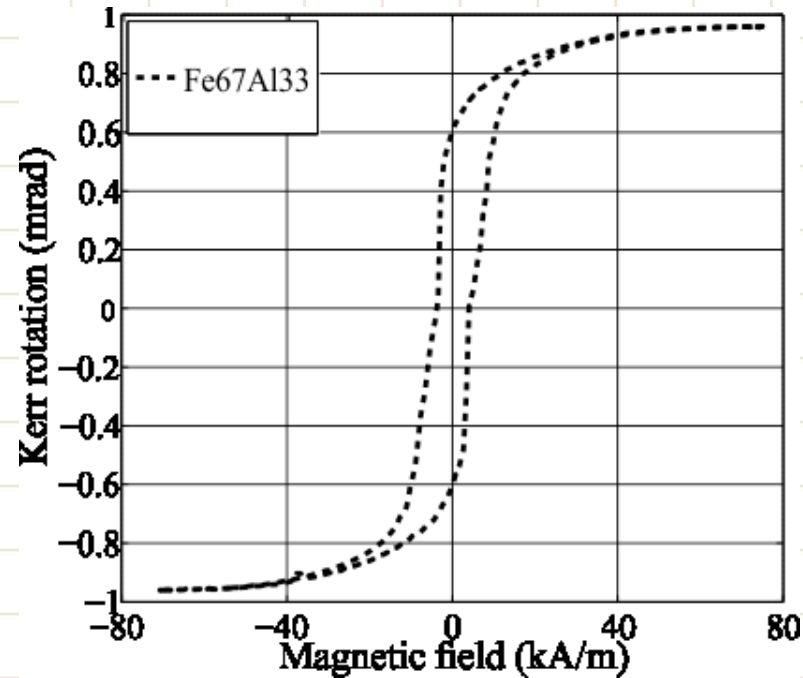


MOKE surface magnetic domains

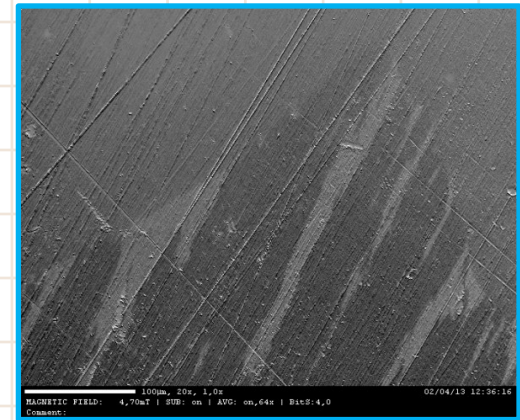
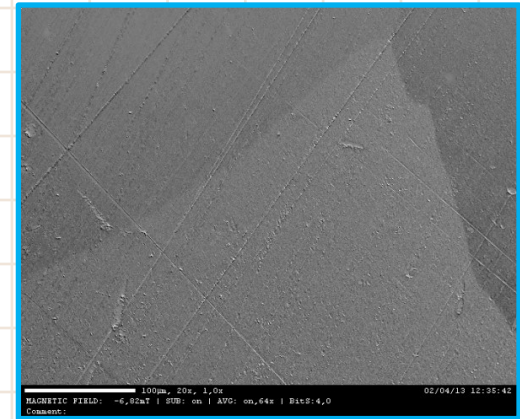
Results



VSM volume hysteresis loop

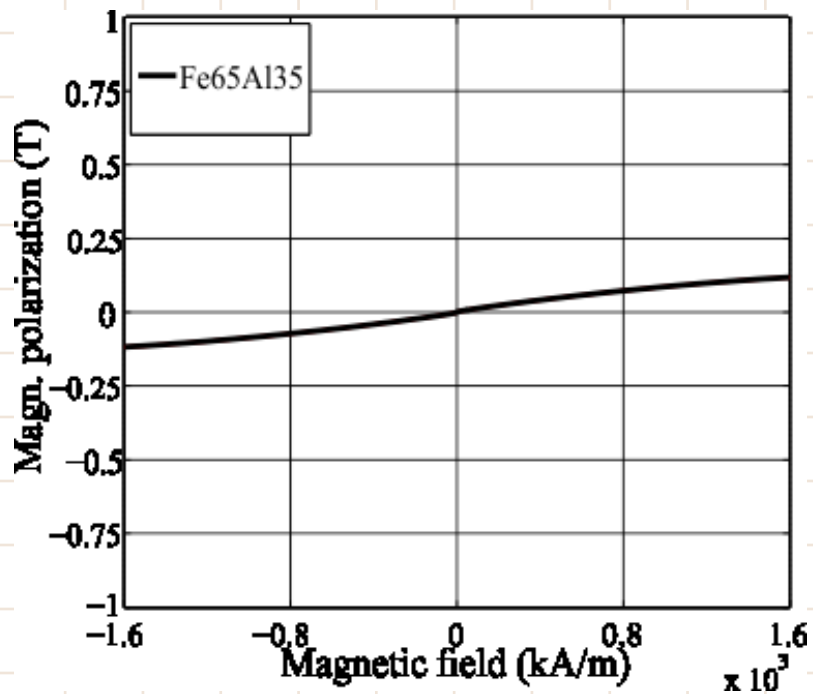
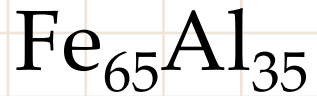


MOKE surface hysteresis loop

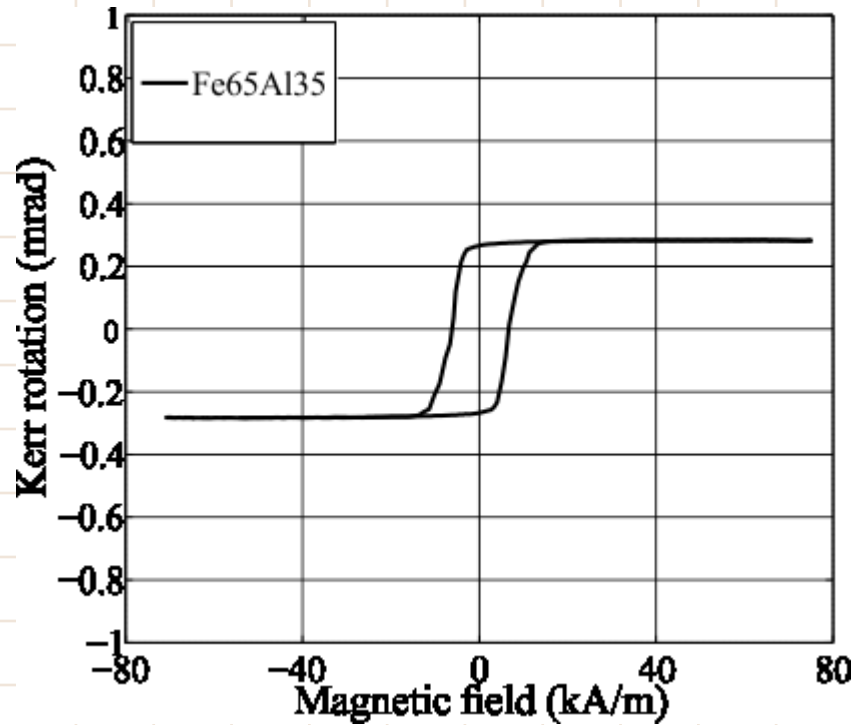


MOKE surface magnetic domains

Results

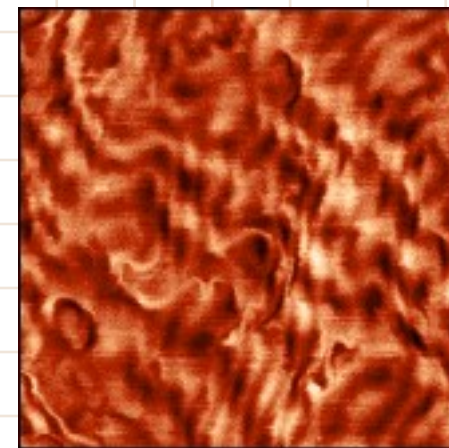
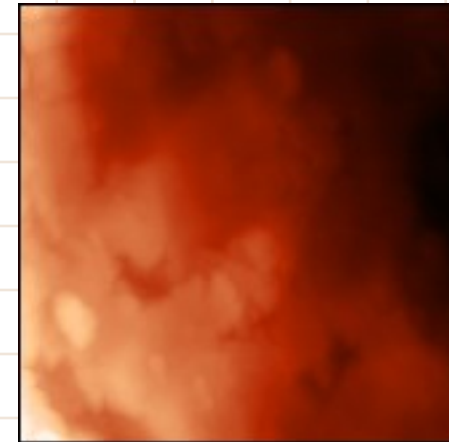


VSM volume hysteresis loop



MOKE surface hysteresis loop

10 μm x 10 μm



AFM/MFM
Topography/magnetic
contrast

Conclusions

- We showed the differences between the volume and surface magnetic properties.
- The bulk magnetic properties are in agreement with phase diagram (i.e. $\text{Fe}_{82}\text{Al}_{28}$ ferromagnetic behavior, $\text{Fe}_{67}\text{Al}_{33}$ and $\text{Fe}_{65}\text{Al}_{35}$ paramagnetic behavior).
- The surface magnetic properties of the Fe-Al with higher Al content document magnetic transformation.

Explanation:

Formation of the oxide layer at the surface and/or depletion of the surface layers by aluminium atoms