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### Giant magnetoimpedance of iron single crystals

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#### Abstract

Iron whiskers had ever been objects of basic physical research because of their unprecedented purity and well-defined surfaces. High-field magnetoresistance investigations at low temperatures provided information on the nature of the Fermi surface in iron. Further studies of the temperature dependence at low magnetic fields helped to differentiate between different magnetoresistive effects [1]. In this work, measurements of the magnetoimpedance of iron single crystals have been carried out at room temperature. Simultaneously, the magnetic surface domain structure of the samples was imaged by Kerr microscopy. Iron whiskers of 70 to 105  $\mu\text{m}$  in diameter with  $\langle 100 \rangle$  and  $\langle 111 \rangle$  growth axes have been used for the experiments.

The impedance of  $\langle 100 \rangle$  and  $\langle 111 \rangle$  whiskers strongly depends on external magnetic field as well as on the current. A clear correlation between domains and magnetoimpedance was observed. For  $\langle 111 \rangle$  whiskers, impedance is at a maximum at low external field and current values. In this regime, Kerr images show a multidomain structure. The domains can be interpreted as circumferential domains of opposite sense. Comparison of  $\langle 111 \rangle$  whiskers with FeCoSiB wires [2] is reasonable, because both samples show a similar domain structure in demagnetized state. In case of  $\langle 100 \rangle$  whiskers, this comparison is not so straightforward. The Landau structure at  $H = 0$  is very different from the alternating circumferential domain structure in GMI wires and ribbons. However, upon applying a threshold electrical current the Landau structure becomes replaced by another magnetic state, which is most probably of circumferential magnetization. This domain state coincides with large values of the magnetoimpedance.

In all cases the maximum change in impedance is correlated with drastic changes in the domain structure. In conclusion, the magnetoimpedance of iron whiskers is governed by a giant magnetoimpedance effect. The observed impedance ratios are as high as 45 %.

#### References

- [1] G. R. Taylor, A. Isin and R. V. Coleman, *Phys. Rev.* **165**, 621 (1968).
- [2] R. S. Beach and A. E. Berkowitz, *Appl. Phys. Lett.* **64**, 3652 (1994).

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