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P. Leinenbach, U. Memmert, J. Schelten, and U. Hartmann
FABRICATION AND CHARACTERIZATION OF ADVANCED PROBES FOR MAGNETIC FORCE MICROSCOPY

Advanced probes for magnetic force microscopy have been produced by e^--beam lithography and Ar^+-ion etching. The probes consist of individual CoCrPt, Fe, or Ni particles with a typical size of $100\times100\times100$ nm^3, located at the tip apex of commercial cantilevers. They were compared to conventional thin film probes by performing magnetic force imaging on hard disc test patterns and soft garnet films. The advanced probes yield a considerable improvement in lateral resolution due to the three-dimensional confinement of the magnetically active tip volume. For soft magnetic samples the improvements are even more striking since the low stray field of the new probe allows nondestructive imaging at much smaller probe–sample spacing than achievable by conventional probes.

Proc. NANO 5 Conf., Birmingham, England, 1998; Appl. Surf. Sci. ***144/145****, 492 (1999)*

B. Hillebrands, S.O. Demokritov, C. Mathieu, S. Riedling, O. Büttner, A. Frank, B. Roos, J. Jorzick, A.N. Slavin, B. Bartenlian, C. Chappert, F. Rousseaux, D. Decanini, E. Cambril, A. Müller, and U. Hartmann
ARRAYS OF INTERACTING MAGNETIC DOTS AND WIRES: STATIC AND DYNAMIC PROPERTIES
Proc. 4th Intern. Symp. on Phys. of Magn. Mat., Sendai, Japan; J. Magn. Soc. Jpn. ***23****, 670 (1999)*

U. Hartmann
MAGNETIC FORCE MICROSCOPY

This review on magnetic force microscopy does not provide an exhaustive overview of the past accomplishments of the method but rather discusses the present state of the art. Magnetic force microscopy is a special mode of noncontact operation of the scanning force microscope. This mode is realized by employing suitable probes and utilizing their specific dynamic properties. The particular material composition of the probes and the dynamic mode of their operation are discussed in detail. The interpretation of images acquired by magnetic force microscopy requires some basic knowledge about the specific near-field magnetostatic interaction between probe and sample. The general magnetostatics as well as convenient simplifications of the general theory, which often can be used in practice, are summarized. Applications of magnetic force microscopy in the magnetic recording industry and in the fundamental research on magnetic materials are discussed in terms of representative examples. An important aspect for any kind of microscopy is the ultimately achievable spatial resolution and inherent restrictions in the application of the method. Both aspects are considered, and resulting prospects for future methodical improvements are given.

Annu. Rev. Mat. Sci. ***29****, 53 (1999)*

Y. Xu, V. Dworak, A. Drechsler, and U. Hartmann
ANISOTROPIC, LOW-FIELD MAGNETORESISTANCE OF POLYCRYSTALLINE MANGANITE SENSORS

Magnetic-field sensors of bulk $La_{0.67}Sr_{0.33}MnO_3$ and $La_{0.67}Ba_{0.33}MnO_3$ were fabricated. The investigations show that a large low-field magnetoresistance (MR) is exhibited by the polycrystalline samples. MR ratios of the sensors as large as 20% at 77 K and 1.5% at 298 K were observed in fields of 700 Oe. Corresponding field sensitivities as high as 170%/T at 3 mT and 298 K, and 700%–960%/T at 3–8 mT and 77 K were obtained. The low-field MR is associated with intergranular transport of spin-polarized electrons. It is found to be highly anisotropic. The phenomenon is discussed in terms of spin-polarized transport through two kinds of grain boundaries. These represent two extremes of grain-boundary environments.

Appl. Phys. Lett. ***74****, 2513 (1999)*

G. Nicolay, R. Claessen, F. Reinert, V. N. Strocov, S. Hüfner, H. Gao, U. Hartmann, E. Bucher
FAST EPITAXY OF AU AND AG ON WSE2

Evaporation of Ag and Au on single crystal surfaces of the layered compound WSe_2 leads to epitaxial growth of (111) noble metal surfaces even at deposition rates several orders of magnitude higher than previously reported. The metal overlayers are studied by atomic force microscopy, low energy electron diffraction, angle-resolved photoemission and electron energy loss spectroscopy.

Surf. Sci. ***432****, 95 (1999)*

A. Wienss, G. Persch-Schuy, M. Vogelgesang, U. Hartmann
SCRATCHING RESISTANCE OF DIAMOND-LIKE CARBON COATINGS IN THE SUB-NANOMETER REGIME

In order to examine the scratching resistance of ultrathin hydrogenated amorphous carbon (a-C:H) coatings used in magnetic storage devices, a large number of scratches with reproducible residual groove depths well below 1 nm has been examined. All measurements were carried out with an atomic force microscope and diamond-tipped cantilevers. The analysis of such shallow scratches is made possible by means of an image processing procedure which minimizes surface roughness effects using subtraction imaging. This method was applied to a series of sputter-deposited, fully aged, unlubricated amorphous coatings with different hydrogenations. For low hydrogen content in the sputtering gas, the scratching resistance decreased with an increasing amount of hydrogen, in accordance with many other experiments. In contrast, an unusual slight improvement of the scratching resistance for a further increase of hydrogenation was obtained.

Appl. Phys. Lett. ***75****, 1077 (1999)*

A. Wienss, F. Krause, G. Persch-Schuy, U. Hartmann
NANOHARDNESS TESTING OF DIAMOND-LIKE CARBON ON MAGNETIC STORAGE COMPONENTS
*in: **Werkstoffprüfung**, Eds.: W. J. Muster, J. Ziebs und R. Link (Wiley-VCH, Weinheim, 1999)*

U. Hartmann
SCHWACHE MAGNETFELDER IN NANOSTRUKTUREN
*Spektr. d. Wiss., **Dez**., 100 (1999)*

E. zur Mühlen, P. Koschinski, S. Gehring, R. Ros, L. Tiefenauer, E. Haltner, C.-M. Lehr, U. Hartmann, F. Schwesinger, and A. Plückthun
FORCE MICROSCOPY OF CELLS TO MEASURE BIOADHESION,
*in: **Bioadhesive Drug Delivery Systems**, Eds.: E. Mathiowitz, D.E. Chickering III, and C.-M. Lehr (Dekker, New York, 1999)*

U. Hartmann
MAGNETISCH ABBILDENDE RASTERSONDENVERFAHREN
30. IFF-Ferienkurs, B7.1, FZ-Jülich, (1999)

U. Hartmann (Ed.)
MAGNETIC MULTILAYERS AND GIANT MAGNETORESISTANCE: FUNDAMENTALS AND INDUSTRIAL APPLICATIONS
*Springer series in Surf. Sci. **37**, 1 (1999)*