Sensors for scanning probe microscopy

In our global information community, always faster information processing and always higher information density are expected. This means that the dimensions of the electronic devices have to become smaller and smaller according to the SEMATEC roadmap [1]. Structures in the range of 50 nm are expected in the next few years. This is a great technological (e.g. lithographic and etching techniques) and material challenge. Therefore, scanning probe microscopy (SPM) techniques for highest lateral, time and frequency resolution are becoming more and more important, e.g. for material characterisation and modelling, mask-less lithography and memory devices. On the other hand, the technological progress obtained in microelectronics can be applied for the reproducible fabrication of the corresponding sensors for SPM. This will be shown below.

Results

2.1 Sensors for scanning optical near-field microscopy

Scanning optical near-field microscopy (SNOM) is a prominent member of the scanning probe microscopy [2, 3] techniques. The fascination is based on the possibility to circumvent the optical diffraction limit of convention light microscopy. Figure 1a shows the principle, and Fig. 1b the technological realisation. The light enters the hollow tip and...
One problem of the aperture-based SNOM is the extreme intensity of the evanescent wave. It would therefore be low desirable to realise a coaxial sensor as shown in Fig. 2a. Its realisation, in co-operation with Prof. Stuke, MPI Göttingen, by using focused ion beam (FIB) technology is shown in Fig. 2b [4].

But this is a technique where each coaxial sensor has to be fabricated separately. A batch technique would be advantageous. Figure 3 shows therefore different sensors fabricated in such a way, where the angular dependence of the reactive ion etching (RIE) technique has been applied. The outer shell is a Cr-metal layer in this case and the tip is made of silicon.

Besides the SNOM application, these structures can also be applied as electron emitters. To increase the effectiveness as electron emitters the silicon tips can be covered with diamond or diamond-like-carbon films. Due to the batch technique large arrays of such tips can be realised, as shown in

FIGURE 2  a Principle of a coaxial SNOM probe. b Coaxial SNOM probe realised with FIB technique [6, 7]

an evanescent wave emerges from the aperture. In contrary to conventional microscopy the diameter of the aperture determines the resolution rather than the wavelength. With the mentioned technology and a patented self-organising aperture-opening technique, aperture sizes of about 50 to 100 nm can reproducibly be obtained [4].