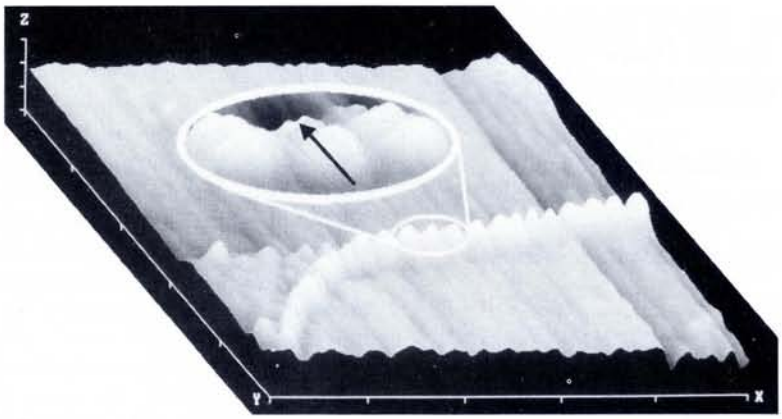

Fig. 6 — STM imaged of a slightly curved fragment of an unstained DNA polymer (scanned area: 90 × 90 nm²). The image alternates between a repeating structure and a broad depression, identified as the major groove. The right-handed rotational sense of the helical structure is indicated with an arrow. The 4× magnified insert reveals the bipartite structure, tentatively associated with the minor groove.

with extremely high densities and storage capacities.

The fabrication of atomic-scale components and devices using STM is illustrated by the recently observation of the tunnel-diode effect on an atomic scale at Si(111) surfaces with a very high subsurface concentration of boron. The observed current-voltage characteristics were related to the presence or absence of the boron dopants at individual atomic sites (size $\approx$ 0.5 nm^2) [6].

Biological Materials

It has recently been the goal of several research groups to apply the superior resolving power of the STM to biomaterials. Unfortunately however, biomaterials are in general poor conductors, are easily deformed or damaged, and since they must usually be deposited on a conducting surface at low concentration, they are hard to find.

Fig. 6 shows a recent high-resolution image of unstained, air-dried DNA fragments ($\leq$ 500 base pairs) deposited on a freshly cleaved, highly oriented pyrolytic graphite substrate. The observed structure is believed to be DNA preserved in the B conformation structure for the following reasons: The DNA polymer alternates between a repeating structure and a broad depression, identified as the major groove. The helical structure has a right-handed rotational sense, it repeats at regular intervals of 3.8 ± 0.6 nm, has a width of 2.5-3.0 nm and a height 1.6-1.8 nm, all in good agreement with the expectation for random sequence DNA. In the high-resolution image, each helical repeating structure appears bipartite with a narrow depression on top, which tentatively can be interpreted as the minor groove since the width of the structure is 1.5 ± 0.1 nm, close to the expected width for the minor groove in B-DNA [7].

Concluding Remarks

The STM is a fascinating new instrument, capable of exploring the atomic scale realm. Its development from being a complicated, home-made research instrument to a fairly low-cost commercial product will diversify the applications of the instrument tremendously. New areas of application are being developed continuously: for example, it is possible to study electrode surfaces during electrochemical reactions taking place in an electrolytic cell [8]. Finally, the development of the atomic force microscope, which is capable of imaging nonconducting surfaces, will have a significant impact on the study of biological, polymeric and other materials of these types.

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REFERENCES

[1] Golovchenko J.A., *Science* **232** (1986) 48; Takanayagi K. *et al.*, *J. Vac. Sci. Tech.* **A3** (1985) 1502.
[2] Avouris Ph. and Wolkow R., *Phys. Rev. Lett.* **B39** (1989) 5091.
[3] Villarrubia J.S. and Boland J.J., *Phys. Rev. Lett.* **63** (1989) 306.
[4] Coulman D.J., Winterlin J., Behm R.J. and Ertl G., *to be published*.
[5] Gritsh T., Coulman D.J., Behm R.J. and Ertl G., *Phys. Rev. Lett.* **63** (1989) 1086.
[6] Bedrossian P., Chen D.M., Mortensen K. and Golovchenko J.A., *Nature* **342** (1989) 258.
[7] Bendixen C., Besenbacher F., Laegsgaard E., Stensgaard I., Thomsen B. and Westergaard O., *J. Vac. Tech.* (1990).
[8] Lustenberger P., Rohrer H., Cristoph R. and Siegenthaler H., *Electroanal. Chem.* **243** (1988) 225.

Günther Harbeke

Günther Harbeke died unexpectedly in November 1989 in Zürich of a heart attack while playing tennis at the age of 60. Harbeke was born in Bippen, Germany, on 10 April 1929. He received his undergraduate and graduate education at the Technical University of Braunschweig, where he stayed on as a postdoc in the Semiconductor Laboratory of the PTB. In 1961, Harbeke moved to the RCA Laboratories in Zürich and soon became Group Head for materials research — a position which he held until his premature death. In this position he received three times the Oustanding Achievement Award. He spent sabbatical years at the RCA Laboratories in Princeton, N.J. and at the Max-Planck-Institut FKF in Stuttgart. Günther Harbeke also undertook an academic career starting at the University of Hamburg as a lecturer (1968-1970). He later became an honorary professor at the University of Köln. He was close to crowning his love for Italy, as he was recently called to the new chair of Materials Science at the University of Pavia. Harbeke was the director of two courses of the International School of Materials Science and Technology at Erice, Sicily.

Harbeke dedicated most of his research to the electronic and magnetic properties of materials. He made important and original contributions in many fields, documented by more than one hundred publications, which provided him with a world-wide reputation. Much of his early work and the state-of-the-art in his field is found in the monograph *Optical Properties and Band Structure of Semiconductors* that he wrote with D.L. Greenaway.

Günther Harbeke, however, was not only a first-class scientist and teacher, but also a strenuous supporter of our Society since 1971, when he was elected IOM delegate to the EPS Council. From 1973 to 1975, and again from 1986 to 1989 he was a respected member of the Editorial Board of *Europhysics News*. From 1975 until his death he made an invaluable contribution to the activities of the Condensed Matter Division, first as its Board Secretary, then as the Chairman of the Semiconductor and Insulator Section, and finally as a co-opted member and representative of CMD in the European Materials Research Society and as an Editor of the *European Who's Who in Condensed Matter Physics*. His premature death represents a great loss for EPS. Even more we mourn the loss of a wonderful human being, whom we shall remember and praise for his warm friendliness and optimistic attitude, his respectful fairness with colleagues and students, his tactful ability in handling delicate affairs, and his dedication to his beloved wife Ruth and children.

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