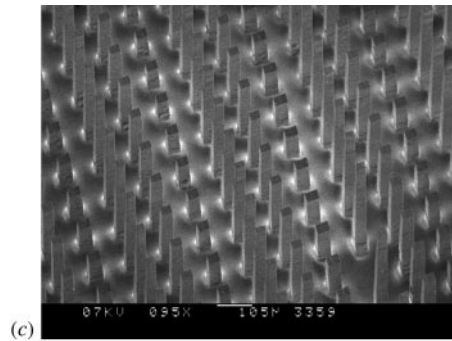
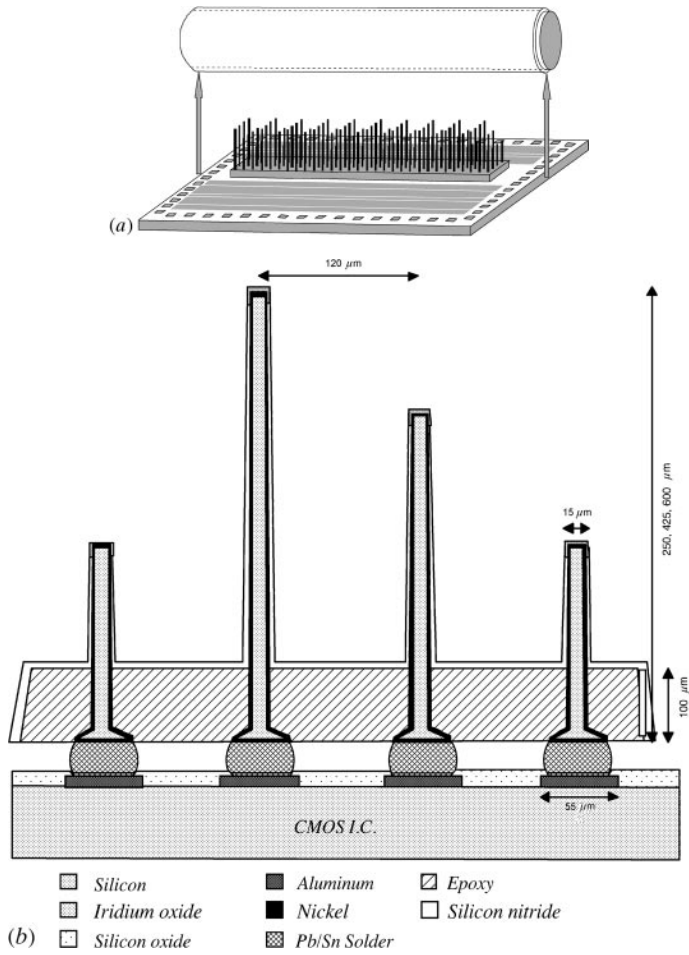
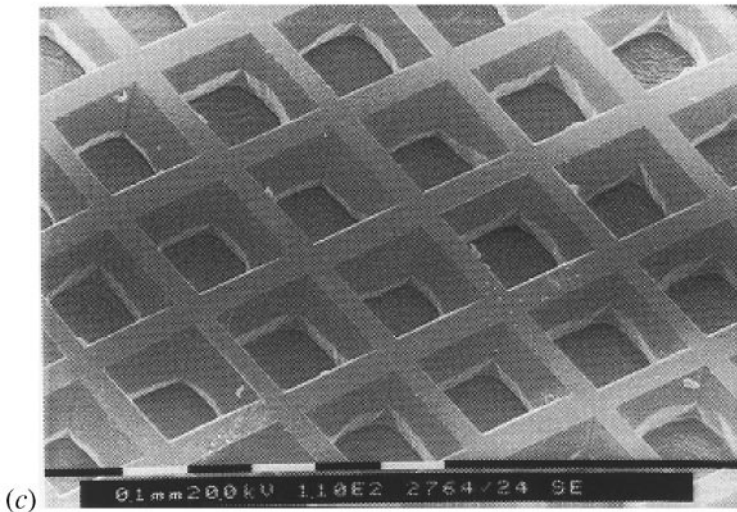
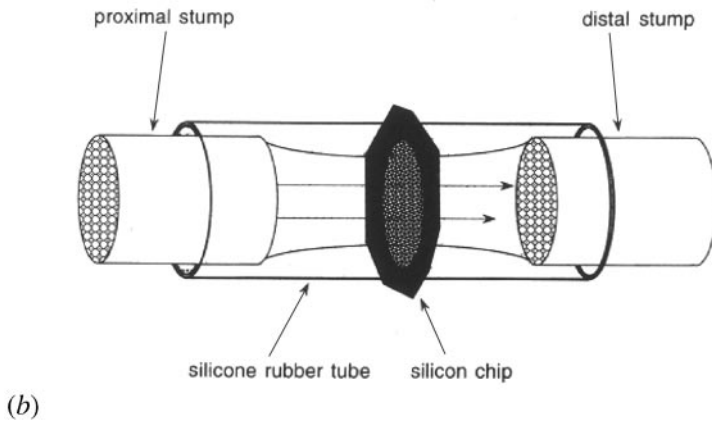
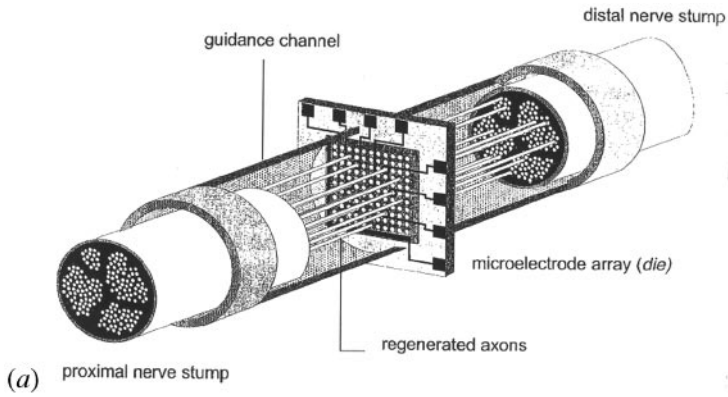


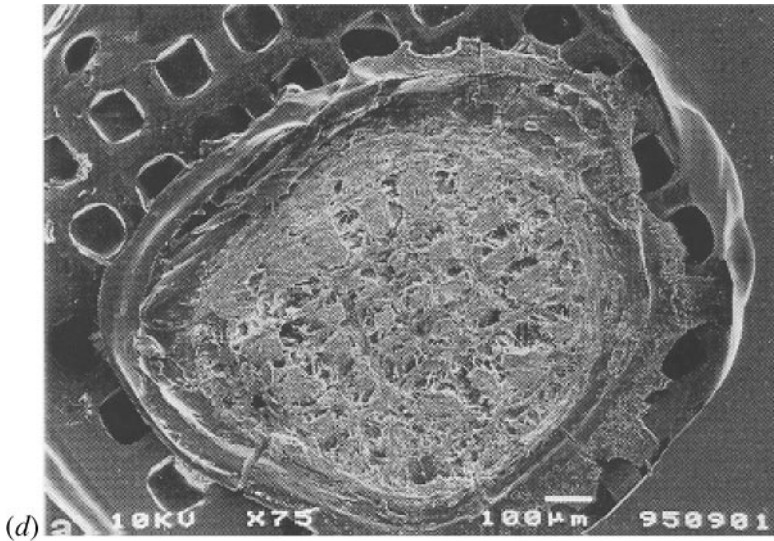
**Figure 12** (top) 1-D silicon tip-shaped array with 12 platinum electrode sites  $50 \times 50 \mu\text{m}$  at a distance of  $50 \mu\text{m}$  from each other. Insulation layer is  $\text{Si}_3\text{N}_4$ , tip thickness is  $60 \mu\text{m}$ . (middle) The device against the tip of a match. (bottom) Insertion of the tip device into fascicle f<sub>2</sub> of a typical peroneal nerve trunk of a rat (diameter 0.5 mm) (from Ref. 26).



**Figure 15** (a) Scheme of the University of Twente 128-electrode 3-D glass-silicon array (UT-128 array), mounted on a CMOS, mixed mode processing chip with dimensions  $4 \times 4$  mm. Needle length is 600, 425, or 250  $\mu\text{m}$ ; width at tip is 15  $\mu\text{m}$ ; and needle spacing is 120  $\mu\text{m}$ . (b) Details of the dimensions and materials used for the UT-128 array. (c) A "sea" of sawn and etched silicon needles of three different lengths, embedded in a glass matrix.



**Figure 18** (Continued)



**Figure 18** (a) Schematic representation of an intelligent neural interface (sieve array) implanted into an intersected nerve (from Ref. 71, Figure 1). (b) Schematic drawing of the silicone chamber model with the inserted silicon chip bridging a 4-mm gap between the proximal and distal stumps of a transected rat sciatic nerve. (from Ref. 70, Figure 3). (c) Detail of the sieve. SEM photograph of a fabricated chip with 100- $\mu\text{m}$  diameter holes (from Ref. 70, Figure 2). (d) SEM photograph of nerve tissue sections distal to a chip with hole diameters of 100  $\mu\text{m}$  after 16 weeks of regeneration. Shown is a minifascicular pattern on the distal surface of the chip. The regenerated nerve structure has a smaller diameter than that of the perforated area of the chip. The circumferential perineural-like cell layer is clearly visible (from Ref. 70, Figure 5, *top*).

and other central neural elements into the cone took place. In 1998 at Emory University School of Medicine, two such electrodes were implanted into the brain of a paralyzed, speech-impaired patient. Such systems are able to control devices directly from the human central nervous system (78).

In 2000, cortical control using many more contacts [32 or 96 electrodes (wire arrays)] implanted into three motor areas of the monkey brain led to successful prediction of arm movements during a drinking task (79). The activity patterns recorded by the electrodes while the monkey performed the arm-movement trajectory could be translated into computer algorithms causing a robot arm to perform the same trajectory. Both of these developments show the feasibility of long-term brain-computer interfacing and control.

Other work (outside the scope of this paper because it involves no microelectrode interfacing) is the research on EEG-based brain-computer interfaces. The patient uses so-called motor imagery (they think about how they would perform a