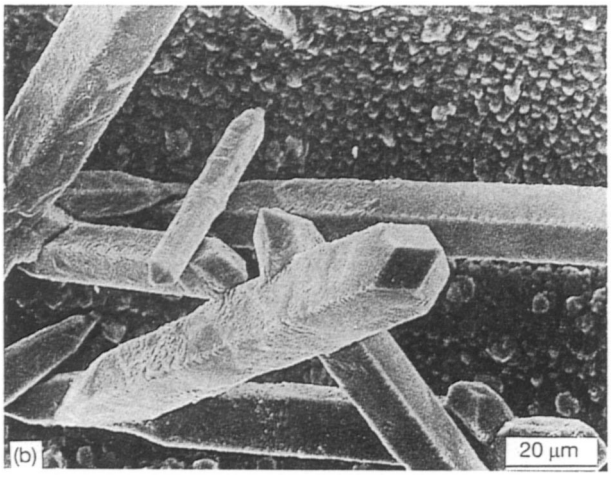

Figure 7 Cadmium oxide whiskers (after Koparanova *et al.*, 1994).

MgO, C, and Al in a $CO + CO_2$ atmosphere. Whiskers grown at 1500 °C for 8 h had diameter and length of approximately 3 μm and 4 mm, respectively, and a growth axis along the [111] direction.

A cobweb whisker of amorphous SiO_2 with a silicon core has been commercialized by J. M. Huber Corporation under the designation XPV1 (Milewski and Katz, 1987). Cobweb whiskers are defined as single crystalline, fibrous materials with diameters below 0.1 μm. The XPV1 whisker has a diameter of about 10 nm. These whisker-like fibers are expected to have extremely high strengths due to their small size and have demonstrated great efficiency in reinforcing polymer matrices where they can be used on their own or together with large-diameter fibers.

Niobium carbide (NbC) whiskers were successfully synthesized via a solid–vapor growth process by heating mixtures of niobium oxide (Nb_2O_5) and carbon black in flowing argon at temperatures >1100 °C (Li *et al.*, 1998b). Whiskers grown at 1120 °C exhibited typically a cuboid cross-section with a square-pyramid tip, diameters of 0.1–2.0 μm, and lengths of 5–100 μm. Growth times in excess of 1 h yielded longer whiskers (>100 μm) with a rectangular cross-section. Whiskers with a hexagonal cross-section were obtained when a higher intial Nb_2O_5:C ratio (1:5.5) was used. Niobium carbide has a high melting point (approx. 3610 °C) and a high electrical conductivity. It is as hard as, but stronger than, titanium carbide.

Aluminum nitride (AlN) whiskers have been prepared by the carbothermal reaction of alumina and carbon powder at 1800 °C (Caceres and Schmid, 1994). Whiskers thus grown are reportedly long and straight single crystals, free of planar defects. They have a diameter of about 2–30 μm and a length in the centimeter range. The high thermal conductivity, low thermal expansion coefficient, high electrical resistivity, and good dielectric properties (Table 5) of aluminum nitride make it an interesting material for electronic applications (Disson and Bachelard, 1991).

Thick whiskers of tin oxide (SnO_2), which is used as a semiconducting sensor to detect H_2, CO, town gas, alcohol, etc., are prepared by heating a mixture of SnO_2 and tin powders at 1200 °C in air (Matsushita and Yamai, 1974). Depending on the processing conditions, these whiskers can be ribbon-shaped with a thickness of about 150 μm and growth direction of [010] or dendritic with rugged surfaces (Yamazaki *et al.*, 1995). The dendritic whiskers are found to exhibit a much greater hydrogen sensitivity than ribbon-shaped whiskers with smooth surfaces. The greater hydrogen sensitivity of the former morphology is attributed to its stepped surfaces.

Cadmium oxide (CdO) whiskers are grown on a CdS substrate by a VLS mechanism (Koparanova *et al.*, 1994). In this process, the surfaces of the CdS crystal are coated with a thin layer of metal catalyst (Si, Pd, Ag, Au, Al, Ni, or Pt). The coated crystals are then annealed in air in the temperature range 670–730 °C when whiskers appear on the CdS surface. In terms of the growth efficiency, the best results are reported with Au, Ag, and Pd coatings. Whiskers thus grown have a face-centered cubic lattice and their morphology largely depends on the metal catalyst used. The largest whiskers, approximately $2\,\text{mm} \times 0.1\,\text{mm} \times 0.01\,\text{mm}$, are obtained with Au; these whiskers are parallelepiped with {100} faces. Figure 7 shows CdO whiskers grown on CdS substrate with Ag coating.