Like oxygen, carbon in multicrystalline silicon appears in concentrations considerably higher than those of the boron dopant concentrations. Typical concentrations of substitutional carbon are in the range of $2–6 \times 10^{17}/cm^3$ generally increasing with increasing block height. The incorporation of carbon into the silicon melt takes place via gaseous CO formation inside the crystallisation chamber by SiO chemically reacting with the graphite heaters. The main problem that is caused by an increased carbon concentration is the formation of needle-shaped SiC crystals (often associated with oxygen and nitrogen, see Figure 6.12) within the silicon material. SiC representing an electrically conductive semiconductor material effectively shorts the solar cell pn-junction, thereby leading to drastically reduced efficiencies. The problem of SiC formation, however, usually occurs only in the uppermost region of the ingot that is anyway rejected because of segregation of metallic impurities.

Despite oxygen and carbon being present in much higher concentrations, transition metals like iron or titanium are considered as much more important with regard to solar cell efficiencies with the exception of the outer edges (width 5–10 mm) of an ingot where in-diffusion from the Si_3N_4 coating may occur and the top segregation region metal point defects in high-quality multicrystalline silicon are present in concentration levels below the detection limit of Deep Level Transient Spectroscopy (DLTS) measurements,
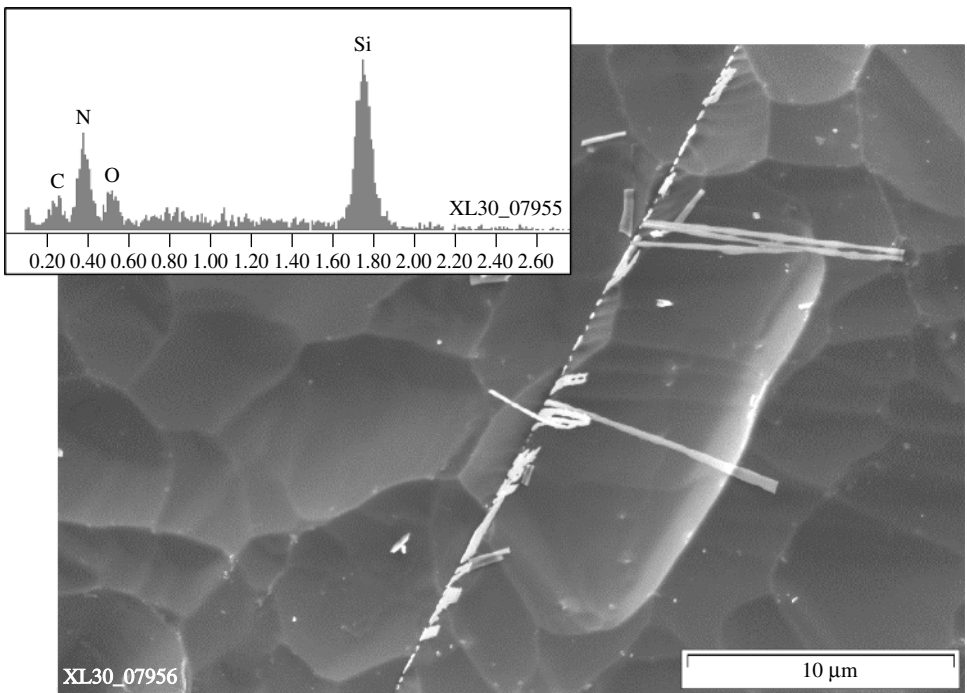

Figure 6.12 SEM (Scanning Electron Microscope) image of a heavily shunted solar cell region. The microscopic investigations reveal needle-shaped structures containing silicon, nitrogen, oxygen and carbon. The shunting mechanism is assumed to be due to electrically conductive SiC that short-circuits the solar cell pn-junction