6.4.3 Wafer Quality and Saw Damage

Several factors are currently considered to determine the quality of the wafers: fracture behaviour, crack density, thickness variations, surface roughness and cleanness. After sawing the surface of the wafer is damaged from the fracture processes and contaminated with organic and inorganic remnants from the slurry. Therefore, the wafers have to be cleaned and the saw damage removed by etching before a solar cell can be fabricated. In addition, the thickness and surface roughness of the wafer may vary, which may be detrimental for some of the further processing steps. All factors are related to the sawing process. Figure 6.20 shows an example of the topology of an as-cut surface. It consists of thickness variations on different length scales. On the scale of millimetres, one can observe grooves parallel to the direction of the wire. They occur particularly under higher loads and can be caused by a deficit of slurry, mechanical vibrations or inhomogeneities of the material. Mostly a large number of parallel wafers are then affected. Grooves on wafers cannot be removed by etching and thus reduce the quality of a wafer.

On a length scale of about 100 μm, the surface may have a wavy topology that is not detrimental unless sharp steps occur. On the micrometer-length scale the surface shows a certain roughness, which is directly related to the microscopic sawing process as described before. The extent of saw damage, which has to be etched away before solar cell processing, lies typically in the range of 5 to 10 μm.

Saw damage also occurs in the abrasive grains and the wire itself. Although the fracture strength of the SiC particles is higher than that of silicon, the grains eventually lose their sharpness owing to breakage that reduces their sawing performance. To reduce the abrasion of the grains, sawing should be done in a stress range where the load on the individual grains lies above the fracture strength of silicon but below that of SiC.

Typically, the wires have diameters between 150 and 180 μm and a length of about 150 to 500 km. They are made of stainless steel and coated with a brass layer.

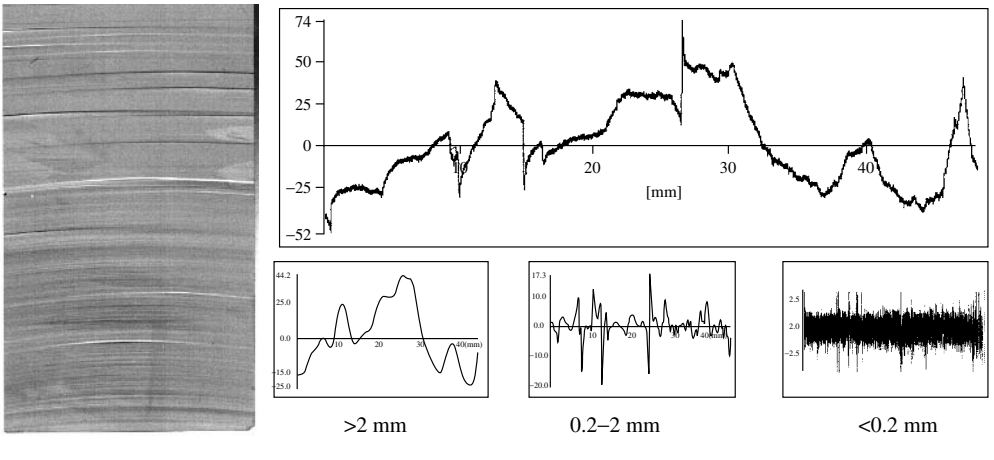

Figure 6.20 Surface structure of a wafer with grooves resulting from uneven cutting. It also shows the bowing of the wire under load during sawing. The surface profile measured by a laser scanner profiler is depicted on the right. Different wavelengths filtered from the profile are shown below