suspension of hard grinding particles. Today, SiC and diamond are the most commonly used abrasives. Both materials are very expensive and account for 25 to 35% of the total slicing cost. The volume fraction of solid SiC particles can vary between 20 and 60% and the mean grain size between 5 and 30 μm. For polishing smaller grain sizes below 1 μm are used. The main purpose of the slurry is to transport the abrasive particles to the sawing channels and to the crystal surface. It also has to keep the particles apart and must prevent their agglomeration. The entry of the slurry is a result of the interaction between the wire and the highly viscous slurry. Normally, only a small amount of slurry enters the cutting zone. The factors that are important here are the viscosity and the wire speed, but to understand the fluid mechanical problems that are involved a complex physical modelling is required. First attempts of a description have been reported recently [28–31].

Most of the commercial slurries are based on oil, but water-based or water-washable slurries based on ethylene glycol have been tested as well. Oil slurries have several drawbacks. The wafers can stick together and are difficult to separate after sawing. This problem will become even more severe when the wafer thickness will be reduced in the future. The removal of oil from the wafer surfaces requires comprehensive cleaning procedures. Since large quantities of slurry and SiC are used during sawing and recycling is not possible at present, the disposal of these materials has to be considered as well. The disposal causes, however, environmental hazards and is therefore complicated and expensive. On the contrary, water-based slurries or slurries that are very hygroscopic have the problem that hydrogen gas is generated from the interaction of water and silicon, which can cause the hazard of explosion. From the environmental point of view, water-washable slurries may be the choice of the future.

Material is continuously removed through the interaction of the SiC particles below the moving wire and the silicon surface. The abrasive action of the SiC depends on many factors such as wire speed, force between wire and crystal, the solid fraction of SiC in the suspension, the viscosity of the suspension, the size distribution and the shape of the SiC particles. The viscosity of the slurry depends on the temperature and the solid fraction of particles. Since the temperature rises as a result of the cutting process, the suspension has to be cooled and the temperature controlled during sawing. The viscosity of the slurry also changes because of the continuous abrasion of silicon and iron from the wire. This gradually deteriorates the abrasive action and the slurry has to be replaced or mixed with new slurry after some time.

The kerf loss and surface quality are determined by the diameter of the wire, the size distribution of the SiC particles and the transverse vibrations of the wire. The amplitude of vibration is mainly sensitive to the tension of the wire, but it also depends on the damping effect of the slurry. Increasing the tension will reduce the amplitude of vibration, hence the kerf loss [32]. Typical wire diameters are around 180 μm and the mean size of active particles can vary between 5 and 30 μm. This yields kerf losses around 200 to 250 μm per wafer.

The objective of efficient sawing is to slice with a high throughput, with a minimum loss of slurry and silicon and with a high quality of the resulting wafers. Since many parameters can be changed, the optimisation of sawing becomes a difficult task and today it is mainly done by the wafer manufacturers. They are mostly guided by experience. In