Basic knowledge about the microscopic details of the sawing process is required in order to slice crystals in a controlled way. In the following section, the principles of the sawing process will be described as far as they are understood today.

6.4.1 Multi-wire Wafering Technique

After crystal growth the silicon ingots are cut in a first step by band saws into columns with a cross section that is determined by the final wafer size. Standard sizes are about $10 \times 10\ cm^2$, but larger wafers sizes up to $15 \times 15\ cm^2$ are increasingly used in the solar cell technology. The columns are glued to a substrate holder and placed in a multi-wire saw that slices them into the final wafers. The principle of the multi-wire technology is depicted in Figure 6.15. A single wire is fed from a supply spool through a pulley and tension control unit to the four wire guides that are grooved with a constant pitch. Multiple strands of a wire net (known as a web) are formed by winding the wire on the wire guides through the 500 to 700 parallel grooves. A take-up spool collects the used wire. The wire is pulled by the torque exerted by the main drive and slave as shown in the figure. The tension on the wire is maintained by the feedback control unit at a prescribed value. The silicon column on the holder is pushed against the moving wire web and sliced into hundreds of wafers at the same time. The wire either moves in one direction or oscillates back and forth. Solar cell wafers are mainly cut by a wire that is moving in one direction, whereas wafers for the microelectronic industry are cut by oscillating wires. Cutting in one direction allows higher wire speeds between 5 and 20 m/s, but yields less planar surfaces. Smoother and more even surfaces are obtained by oscillating sawing. Depending on the pulling speed, the wires have a length between 150 and 500 km in order to cut a single column in one run. The wire material is usually stainless steel.

Cutting is achieved by an abrasive slurry, which is supplied through nozzles over the wire web and carried by the wire into the sawing channel. The slurry consists of a

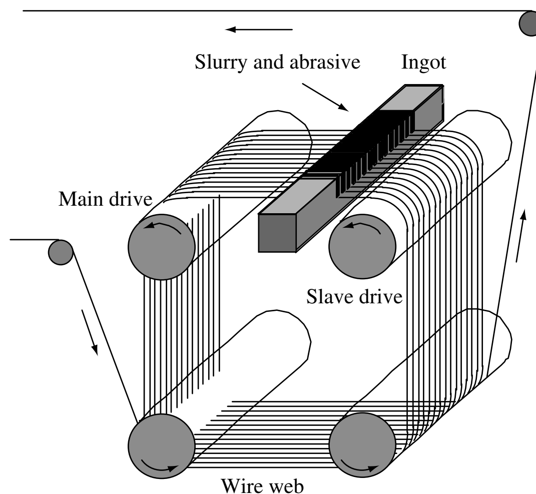

Figure 6.15 Schematic diagram depicting the principle of the multi-wire sawing technique