A disadvantage of the process is the generation of powder due to homogeneous decomposition of SiH_4 in the free reactor space and the hydrogen absorption into the polysilicon deposition layer.

5.4.4 Economics and Business

The polysilicon business is completely dedicated to the semiconductor industry and therefore is a high-technology, fast-growing (annual growth approximately 10% on average) and cyclical business. With an average price of 50 US$ per kg and a sale of 20 000 MT, it is a global business of one billion US$ supporting a multibillion US$ semiconductor market. Physical volumes are small but added value is high. This may be judged by taking into consideration that metallurgical grade silicon at 1 US$ per kg is the only raw material necessary. Small amounts of hydrogen and chlorine or tetrachlorosilane are purchased as make-up to compensate losses occurring in the closed-loop process.

The industry is extremely capital-intensive. Plants have capacities ranging from 1000 to 5000 MT. One unit of 1000 MT may require a capital expenditure of 100 million US$.

The second characteristic is that the decomposition process requires large amounts of energy. In the early stages of the industry, consumption of 350 kWh per kg polysilicon was not unusual. Efficiencies improved to 150 to 160 kWh per kg, and advanced processes are now about 100 kWh per kg. The fluidised bed process is even more efficient.

The industry is concentrated in the United States (five plants, four producers), the European Union (two plants, two producers) and Japan (three plants, two producers). Small plants are also operating in PR China and the Commonwealth of Independent States (CIS).

Polysilicon is then melted and solidified into a single crystal either by the Czochralski (CZ) or by the floating zone method (FZ). Large single crystal ingots or boules are then sliced into wafers onto which semiconductor devices are built. About 15% of polysilicon production is used to make single- and multicrystalline silicon wafers for solar cell applications.

As it is an important aspect of the PV industry and sciences, crystallisation technologies are covered in Chapter 6 of this handbook and some basic principles are given in the next section of the present chapter.

5.5 CURRENT SILICON FEEDSTOCK TO SOLAR CELLS

Elemental silicon is used in photovoltaics as the main semiconductor material converting light to electricity. Two main classes of silicon must be distinguished: amorphous and crystalline. Crystalline cells are either single- or multicrystalline. Within each group of technology several variants may be distinguished. The elaboration of the cells by different silicon-based technologies and their characteristics are described in Chapter 7. According to recent market surveys [1–3], crystalline silicon is strengthening its dominant position, particularly multicrystalline silicon (including ribbon) with new capacities steadily coming on stream. (See Table 5.3 and References [1–3].)