2. Another German company Wacker Chemie, which is one of the leading suppliers of electronic grade polysilicon and a great contributor to the development of materials to photovoltaics in the past, has decided to build a pilot plant to develop solar grade polysilicon by the reduction of trichlorosilane in a fluidised bed reactor. Under industrial conditions, each fluidised bed reactor should produce more than 500 MT/year and should be economical enough to meet the cost target of the solar cell industry.
3. The Japanese company Tokuyama Corporation, also a leading polysilicon manufacturer, has announced at a recent symposium its intention to develop a new deposition process using trichlorosilane in order to specifically produce solar grade silicon [85]. More technical details had not been presented at the time of writing this chapter. The reader is invited to consult later publications.

5.7.4 Other Methods

Besides the large avenues described above, one finds some other routes. The following processes are worth noting.

1. The aluminothermic reduction of silica

$$3SiO_2 + 4Al = 3Si + 2Al_2O_3 \tag{5.43}$$

explored by Wacker [39].

2. The electrolytic transfer of silicon from an anode made partly of metallurgical grade silicon alloyed with Cu in (Cu_3Si-Si) to a graphite cathode through a liquid electrolyte made of KF:LiF:SiK_2F_6 as described by Olson *et al.* [86–88].

$$\text{Si(metallurgical grade)} \rightarrow \text{Si}(4+) + 4\text{e}(-) \rightarrow \text{Si(refined)} \tag{5.44}$$

Although revisited by several R&D groups, these methods do not seem to have been the subject of extensive new programmes since the eighties.

5.8 CONCLUSIONS

At the time this handbook was written, silicon is the dominant PV material with more than 98% of cells and modules based on it. Crystalline technologies account for nearly 90%. We do not see new materials displacing silicon in the foreseeable future. The crystalline technologies require significant consumption of pure silicon. Purity requirements have not been exactly defined with the industry selecting silicon raw materials among the residuals from single-crystal pulling and second-grade polysilicon. At present, these sources are not sufficient to cover the rapidly growing demand from the solar industry. Polysilicon produced specifically for solar applications and prime-grade polysilicon are extensively used. This has the negative consequence of increasing the cost of solar cells and hence of slowing the market deployment of solar electrical energy. Research on a new dedicated route to solar grade silicon decoupled from the semiconductor business cycles has been going on for almost 30 years. Two directions still retain most of the attention of scientists and technologists: the further development of pyrometallurgical treatments of liquid silicon