1 Wafer fabrication

1.1 Properties of silicon

Silicon is the chemical element with the atomic number 14 in the periodic table of the elements. Silicon is a classic semiconductor, its conductivity lies between that of conductors and dielectrics. Naturally silicon (from the latin silex/silicis: pebbles) occurs only as oxide: silicon dioxide (SiO_2) in form of sand, quartz, or silicate (compounds of silicon with oxygen, metals and others). Thus silicon is a very cheap starting material, whose value is determined with further processing. Other semiconductors such as germanium or gallium arsenide compound semiconductors offer substantially improved electrical properties than silicon: the charge carrier mobility and thus the resulting switching speeds are significantly higher in germanium and GaAs. However, silicon has significant advantages in contrast to other semiconductors.

On a silicon crystal oxide layers can be produced very easily, the resulting silicon dioxide is an insulator of highest quality which can be fabricated precisely on the substrate. To create similar insulators on germanium or gallium arsenide is very expensive. The possibility to change the conductivity by doping silicon is another big advantage. Other substances are in part very toxic, and compounds with these elements are not as durable and stable as in silicon. Requirement for the use of silicon in semiconductor manufacturing is that the silicon is present in an ultrapure form as single crystal. This means that the silicon atoms in the crystal lattice are regularly arranged and there are absolutely no undefined impurities in the material.

In addition to the single crystal, there is polysilicon (poly = many) and amorphous silicon (a-Si). While the single crystal silicon is the basis for microelectronics in form of circular wafers, the polycrystalline silicon is suitable to fulfill specific tasks (e.g. masking, gate electrode, ...). Polysilicon is made up of many individual irregularly arranged single crystals, and can be deposited and patterned very easily. Amorphous silicon does not have a regular but a disordered lattice structure and plays no role in semi-

conductor manufacturing, but amorphous silicon offers advantages over other forms of silicon in the manufacture of thin film solar cells.