1 Fundamentals

1.1 The elements, the periodic table

1.1.1 Elements

An element consists of several identical atoms and is a substance that can not be further decomposed by chemical means. The mass of elements is determined only by the number of protons and neutrons, since the electron mass is negligible. Hydrogen with one proton and no neutron has the mass number 1, the next heavier element, helium, has the mass number 4 (2 protons + 2 neutrons).

The elements are usually named with the initials of their Latin or Greek names (from latin hydrogenium: hydrogen H, from greek lithos: lithium Li).

1.1.2 The periodic table of the chemical elements

The periodic table of the chemical elements (periodic table) lists all the chemical elements with increasing proton number (atomic number) and according to their chemical properties, divided into periods as well as main and subgroups.

The period represents the number of electron shells, the main group, the number of electrons in the outermost shell (1 to 8 electrons). Group 1 and 2 and 13-18 are the maingroups, the group of 3-12 the subgroups.

The first element with one shell (period 1) and one outer electron (group 1) is hydrogen H. The next element, helium He, has only one electron shell and is therefore in period 1 as well. Since the first shell is completely filled with only two electrons, helium is not in group 2, but in group 18 (group of the noble gases).

To add more electrons, one needs to begin a new electron shell. Thus we find lithium Li in group 1, period 2 (two electrons on the first shell, one valence electron on the second

shell). A shell can hold a maximum of $2n^2$ electrons, where n stands for the period.

From the fourth period there exist the groups (3-12) of the transition elements. After the first two valence electrons were added in maingroup 1 and 2 to the outermost shell, more inner shells are filled in the transitional groups for energetic reasons, before the outer shell is completely filled with electrons in maingroup 13-18.

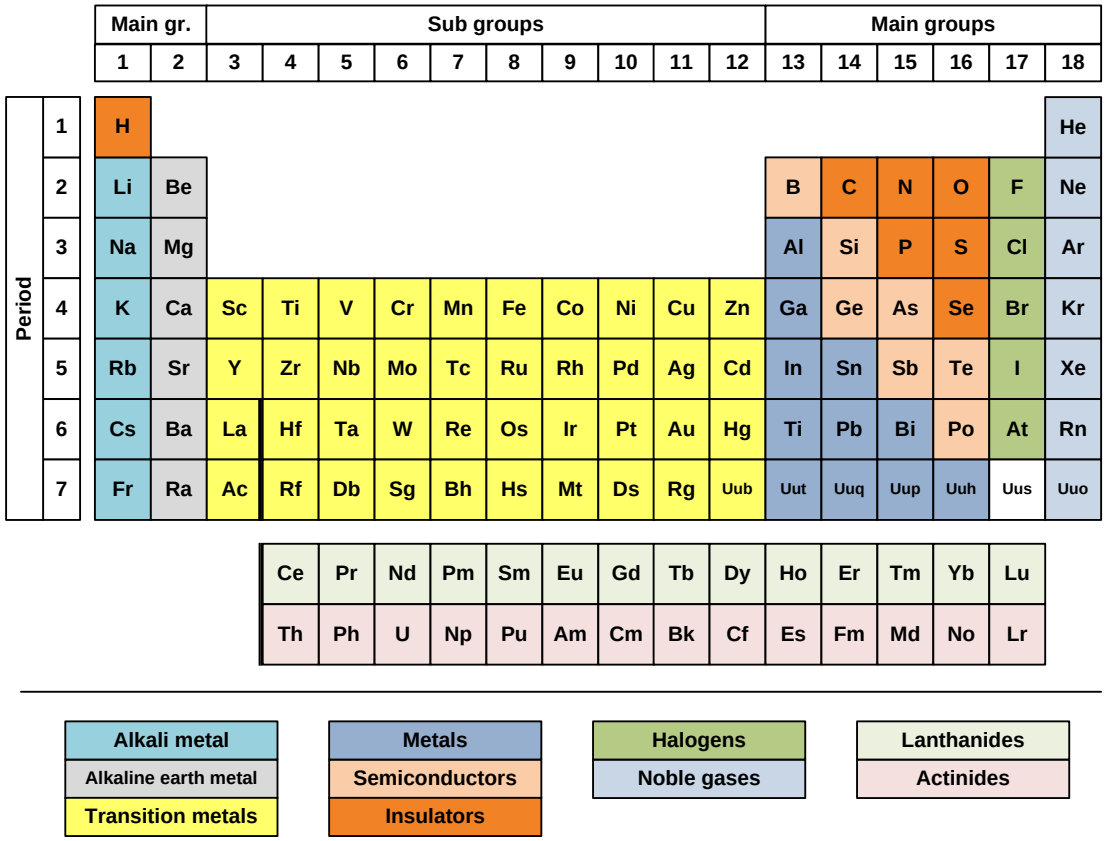

Fig. 1.1: The periodic table of the elements

Elements that occur on the left side in the periodic table are metals. These elements have an aspiration to donate valence electrons to achieve the noble gas configuration. On the right side there are the nonmetals, which are trying to accept additional electrons to achieve the noble gas configuration. In between there are the semimetals such as silicon and germanium.

Element	Particle	Characteristic, application
B Boron	5p, 6n, 5e	3 valence electrons: used for p-doping of silicon
N Nitrogen	7p, 7n, 7e	Stable N_2 molecule: inert gas, cover layer on top of the wafer
O Oxygen	8p, 8n, 8e	Very reactive: oxidation of silicon, insulating layers (SiO_2)
F Fluorine	9p, 10n, 10e	Most reactive element: used for etching in combination with other elements (ie HF, CF_4)
Si Silicon	14p, 14n, 14e	Bulk material in semiconductor industry
P Phosphorous	15p, 16n, 15e	5 valence electrons: used for n-doping of silicon

Tab. 1.1: Important elements in semiconductor industry