

# 1 Fundamentals

## 1.1 The atomic structure

### 1.1.1 The atomic model

An atom is the smallest chemically not further divisible component of matter. Depending on the atom, it is composed of a certain number of electrons, protons, and neutrons. The positively charged protons and the neutrons form the nucleus, which is encircled by the electrons in certain intervals. A naturally occurring atom is electrically neutral, there are just as many positive protons as negatively charged electrons inside an atom. While the number of neutrons can vary. The simplest atom is the hydrogen atom, with only one electron, one proton, and no neutron. The next heavier atom, the noble gas helium, consists of two electrons, two protons, and two neutrons.

According to the Bohr model of the atom the electrons are assigned to so-called shells, which represent different energy levels and therefore are arranged concentrically to the nucleus. There is a maximum of seven shells, which can hold a different number of electrons, the electrons assigned to the outermost shell are known as valence electrons.

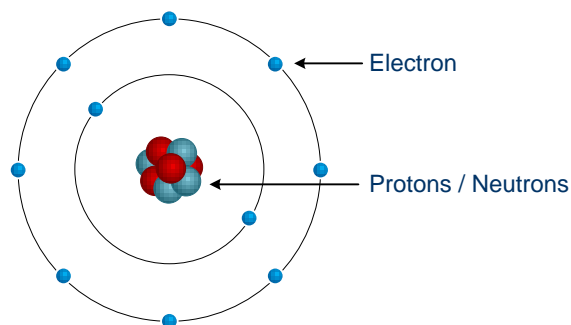


Fig. 1.1: Simplified illustration of a neon atom

The efforts of all the atoms is to fulfill their outermost shell, with eight electrons they reach the so-called noble gas configuration (also electron octet). Elements with few

outer electrons can donate electrons, elements with many outer electrons can accept additional valence electrons (see chapter chemical bonds for details).

### 1.1.2 Properties of atoms

**Mass:** The mass of an atom is determined mainly from the nucleus, since the masses of protons and neutrons ( $1.67 \cdot 10^{-27}$  kg) are about 1800 times larger than the mass of the electrons in the atomic shell ( $9.11 \cdot 10^{-31}$  kg).

**Dimensions:** The diameter of the atomic shell is 0.1 to 0.5 nm, the diameter of the nucleus is even lower by a factor of 100,000. To illustrate: when a pinhead in the middle of a soccer field represents the atomic nucleus, the distance to the corner flags corresponds to the distance at which the electrons orbiting the nucleus.

**Density:** In the nucleus of an atom protons and neutrons are packed extremely densely. If one were to compress the earth to the same density, its radius would be reduced from 6,700,000 m initially to only 100 meters.




			
<b>Particle</b>	Proton	Neutron	Electron
<b>Charge</b>	+1	0	-1
<b>Mass</b>	$1.672 \cdot 10^{-27}$ kg	$1.675 \cdot 10^{-27}$ kg	$0.0009 \cdot 10^{-27}$ kg

Fig. 1.2: Elementary particles

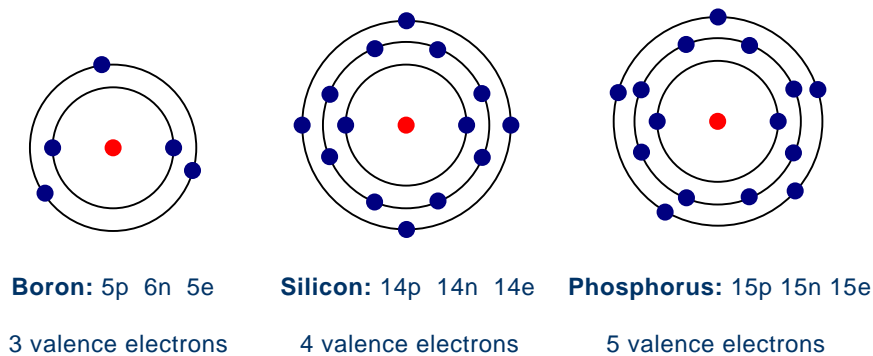


Fig. 1.3: Important elements in semiconductor industry