BERYLLIUM AND CARBON

Atoms of carbon, boron and beryllium in a free condition occupy the least volumes in comparison with atoms of other elements. The relation between molar volumes for these three atoms the following – C : B : Be = 1 : 1.351 : 1.427

The adduced ratio allows calculating approximately the sizes of atoms of beryllium and carbon on the known sizes of atom of boron.

Natural beryllium consists of one isotope – ^{9}Be. Mass of atom is equal 9.01218u, density 1847.7 kg/m^3, temperature of melting 1285°C, temperature of boiling 2470°C.

Under normal conditions beryllium shows hexagonal lattice (α–Be) with parameters a=228.66pm, c=358.33pm, the number of atoms in cell is equal 6. At temperature 1523K (1277°C), i.e. near to temperature of melting, α–Be transform to β–Be with cubic lattice (a=255.15pm, the number of atoms in cell is equal 2). The volume of crystal for one atom is equal 8.099Å^3 – at calculation on density, 8.105Å^3 – at calculation on hexagonal lattice and 8.305Å^3 – at calculation on cubic lattice.

Thus, pure beryllium consists of diatomic molecules, both in solid, and in liquid state.

Crystallographic angles in a molecule of beryllium is the same, as well as in a molecule of lithium (the two-sided corner at top of bipyramid is equal 90°), but diameter of beryllium polytron is much less D_{Be} = 188.900pm.

Crystal of beryllium is anisotropic. Temperature factor of linear expansion for beryllium 99.9% of purity in hexagonal lattice in a range of temperatures from 300 up to 500K is equal $12*10^{-6}$ 1/K in parallel an axis "c" and $9*10^{-6}$ 1/K perpendicularly axes "c".

The small volume of molecule of beryllium explains many of its properties. So, for example, liquid beryllium is dissolved in many metals (Al, Cu, Fe, Co, Ni, Zn), but it is not dissolved in magnesium. Beryllium does not interact with air and water even at temperature of red heat. With molecular hydrogen and molecular oxygen, beryllium starts to interact at temperature above 1300°C, forming, accordingly, hydride BeH_2 and oxide BeO.

The most exact definition of the geometrical form of small atoms can be executed on the basis of electronic microphotos of crystals, but, unfortunately, quality of these, rare in reference books, microphotos very bad.

The electronic microphoto of diamond is rare exception.

Carbon has two crystal modifications – diamond and graphite. Diamond is metastable modification of carbon. At temperature 850°C, diamond burns out in air and transforms to graphite. Stable modification of carbon is graphite, but the crystal structure of graphite has many irregular vacancies and defects. Therefore, parameters of crystal lattices of graphite can give only approximate information on the form and the sizes of atom and molecule of carbon.

Natural carbon consists of two isotopes ^{12}C – 98.90% and ^{13}C – 1.10%. The average atomic mass of carbon is equal 12.011u, the theoretical density for diamond is equal 3515 kg/m^3, temperature of melting ~3820K, temperature of sublimation ~5100K.

Diamond shows two types of crystal lattices – cubic (a=356.703pm, number of atoms in cell 8) and hexagonal (a=252pm, c=412pm, number of atoms in cell 12).

The volume of crystal of diamond for one atom of carbon is equal 5.674Å^3 – at calculation on density, 5.673Å^3 – at calculation on a cubic lattice and 5.665Å^3 – at calculation on a hexagonal lattice. We have executed the modeling for atom and molecule of carbon for the most dense hexagonal lattice, and have found diameter of the carbon polytron D_C=167.678pm.

The modeling has shown, that all modifications of carbon consist of diatomic molecules. In modifications of diamond, molecules are incorporated in clasters, containing in 6 molecules. In modifications of graphite, alongside with 6-molecular clasters, exist 6-molecular left-spiral and right-spiral rings. In fig.1 is shown 6-molecular carbon claster, in fig.2– 6-molecular left-spiral ring, in fig.3 – 6-molecular right-spiral ring.

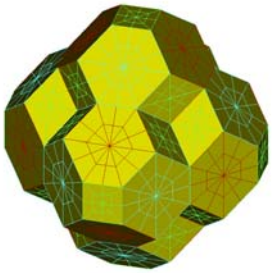

Fig.1
6–molecular carbon claster

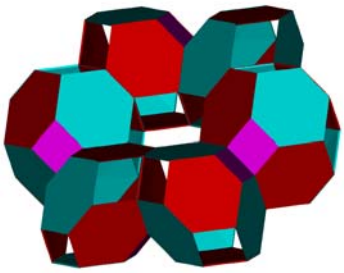

Fig.2
6–molecular carbon left-spiral ring

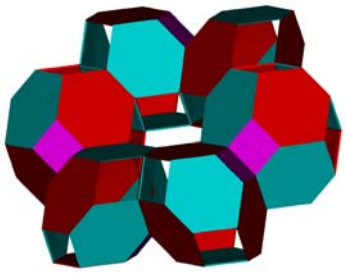

Fig.3
6–molecular carbon right-spiral ring

Clasters, as well as rings, can have left-spiral or right-spiral packing. Four various packings of molecules of carbon in clasters and in rings provide various crystal modifications of diamond, graphite and soot.
For checking of results of polytronic modeling of hexagonal and cubic lattices of diamond, we used the electronic microphoto of crystal of diamond in crystallographic plane 110. This microphoto is made with the help of scanning electronic microscope about 30 years ago and resulted in many directories and textbooks. In fig.4 two projections of 6-molecular carbon claster are shown. In fig.4a the face-to-face projection of hexagonal cell is shown. In fig.4b claster is inclined in the angle 35.26 °, i.e. in the angle, additional to tetragonal.
On top of projections of claster the grid of the blue circles, corresponding to the specified electronic microphoto of crystal of diamond is imposed.

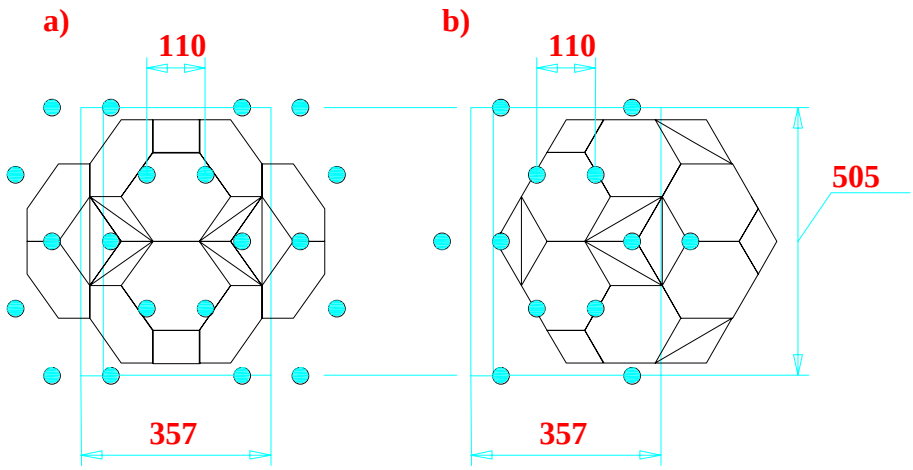

Fig.4
The image of 6–molecular carbon claster at a face-to-face view on hexagonal cell (left design) and at a view under angle 35.26° (right design)

As may be seen from fig.4b, “electronic spots” of microphoto are located on the edges of six-angles cells of claster, i.e. in those places, where are located the emitting nodes of polytrons. Thus, by the example of first eight elements in Mendeleyev's table we have shown, that the polytronic model of structure of atoms describes the picture of structure of microcosm more simply and obviously, than existing paradigm.