(ii) **Covalent bonding.** Atoms can also attain stable electron configuration by sharing the unpaired electrons amongst them.

The *type of bonding resulting from sharing of one or more electrons by the atoms is known as co-valent bonding*. Each atom participating in a covalent bond contributes an electron to the bond and these electrons are shared by both the atoms, rather than being virtually the exclusive property of one of them, as in ionic bond. The sharing takes place in such a way that an electron with *spin up* pairs with another electron with *spin down*, if that electron can occupy the state in accordance with Pauli's exclusion principle. In other words, we can say that *attractive potential* V_a arises due to the pairing of electrons with *anti-parallel spins* and the *repulsive* potential V_r arises due to electrons with *parallel spin*. The covalent bonding is also known as *shared electron pair bonding*.

The simplest example of electron sharing is the hydrogen molecule. When two hydrogen atoms come close to each other, each of the two electrons is attracted by both nuclei. If the electrons have anti-parallel spins, they are capable of moving about both the nuclei and this movement results in the increase of density of electron cloud in the space between the nuclei and the electron clouds of the two overlap and coalesce to form a sort of dumb-bell shaped molecular orbit with the two nuclei at a certain distance and two electrons with anti-parallel spins moving about in this orbit. The negatively charged region of high electron density, in between the positively charged nuclei, draws them closer and the potential energy of the system is lowered to its minimum, resulting into a stable structure. The separation of the two protons in the stable position, is of the order of 0.74 Å and the binding energy is of the order of 4.5 eV.

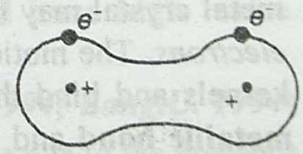

Fig. 3.10

Examples. Purely covalent crystals are relatively few in number. Familiar examples are *diamond (carbon)*, *silicon*, *germanium*, *SiC*. The covalent bond in carbon, formed by sharing of electrons is shown in Fig. 3.11.

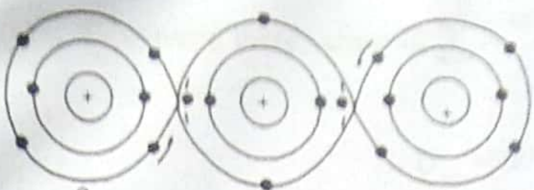

Fig. 3.11

Properties of covalent bonding. The main properties of covalent crystals are:

(i) These substances are made up of individual covalent molecules with weak intermolecular forces.

(ii) These substances are generally insoluble in ordinary liquids but soluble in ether and benzene etc.

(iii) Covalent crystals are very hard since the bond is very strong, *e.g.*, diamond.

(iv) Their dielectric constant is independent of applied field.

(v) They generally exhibit structural and space isomerism due to their directional nature.

(vi) The conductivity of covalent crystal varies over a wide range. Diamond is a good insulator whereas germanium and silicon are semi-conductors and grey-tin is almost a conductor. The conductivity also increases with temperature.

...mples are He, Ar and CH_4.

EC-(7)

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