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TOPIC: - INORGANIC POLYMERS

SILICATES

TOPICS

Introduction

The building block of the silicate minerals

Similarities and differences between silicon and carbon

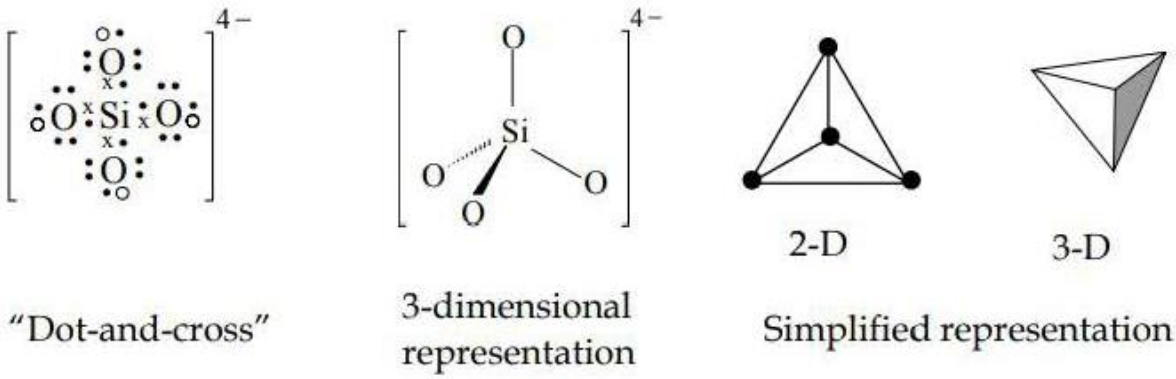
Silicates

1. ## Introduction

   Silicon and oxygen make up most of the Earth's crust. They form the basis of a class of minerals called silicates. All silicates and analogues are derived from the silicate ion, SiO_4^{4-}. The silicon atoms can be replaced by other metals to form analogous compounds, notably the aluminosilicates in which aluminium atoms partially replace the silicon atoms.

2. ## The building block of the silicate minerals

All silicate minerals are built up from the basic unit of silicate(IV) ion, SiO_4^{4-}, which has the following structural representation



"Dot-and-cross" 3-dimensional representation Simplified representation

The Si atom is covalently bonded to 4 oxygen atoms. Each oxygen atom possesses a formal negative charge. Hence each tetrahedral unit has a formal charge of –4. When linked together, the extended units are also negatively charged. Presence of other metallic ions such as Ca^{2+}or Mg^{2+} are necessary for electrical neutrality.

The covalent Si-O bond, having a bond enthalpy of 466 kJ mol^{-1}, is particularly strong compared with the C-C bond which has a bond enthalpy of 347 kJ mol^{-1}. The linkage -Si-O-Si-O- is very stable and instead of existing as discrete units of SiO_4^{4-} ions, the silicates tend to form chains, sheets or networks.

3. Similarities and differences between silicon and carbon

Unlike elements in the other groups which show a general trend of variation in properties down a group, elements of Group IV show similarities as well as differences down the group, especially the first two and the last two members.

The first two members, i.e. C and Si are generally similar in chemical properties. However, their behaviour is not the same as those of the last two typical metallic members, i.e. Sn and Pb.

Although both C and Si atoms tend to form covalent bonds, sp3 sp3 Si - Si overlap is not as effective as sp3 sp3 C − C overlap and as a result, bond enthalpy of C-C bond is 347 kJ mol-1 whereas Si-Si bond is just 226 kJ mol-1. Hence, the fact that carbon is capable of forming long -C-C- chains does not mean silicon also forms stable -Si-Si chains. On the other hand, sp3 sp3 Si - O overlap is of the right order to form strong Si-O bonds, as reflected by a high Si-O bond enthalpy of 466 kJ mol-1. Thus, similar to carbon which forms -C-C-C-C- chains and hence polymers, silicon forms -Si-O-Si-O chains and hence polymeric silicates.