

STRUCTURE OF CERAMIC MATERIALS

The following factors affect structure of ceramics:

Balance of electrical charges of anions and cations

Radius Ratio (r_c/r_a)

Where

r_c – radius of cation;

r_a – radius of anion.

Radius Ratio determines Coordination Number (CN)– the maximum number of anion nearest neighbors for a cation. The anion neighbors do not touch each other.

$r_c/r_a = 0.225 \dots 0.414$ (SiO_2) CN = 4

$r_c/r_a = 0.414 \dots 0.732$ (SnO_2 , PbO_2) CN = 6

$r_c/r_a = 0.732 \dots 1.0$ (ThO_2) CN = 8

Covalent bonding component, which tends to form tetrahedral coordination, may affect the Coordination Number.

Ions are packed with maximum density, providing minimum energy of the structure.

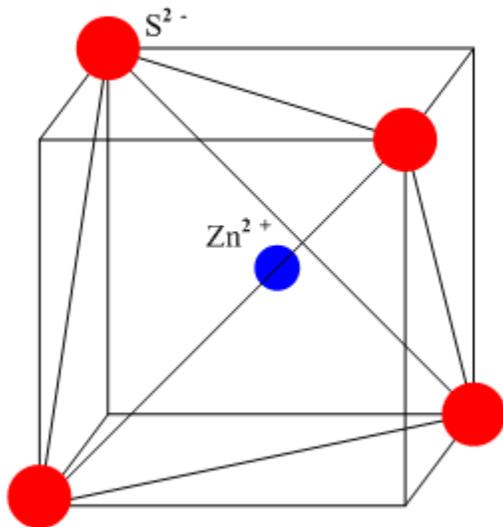
Ceramic structures are classified and designated according to the pattern structures of several natural minerals:

Mineral Name	Formula	Coordination Number	Structure Characterization
Rocksalt	NaCl	6	Octahedral unit cell, cubic appearance
Zincblende	ZnS	4	FCC unit cell with S^{2-} anions at 4 tetrahedral sites
Fluorite	CaF_2	8-cation CN 4-anion CN	FCC unit cell with F^- anions at 8 tetrahedral sites

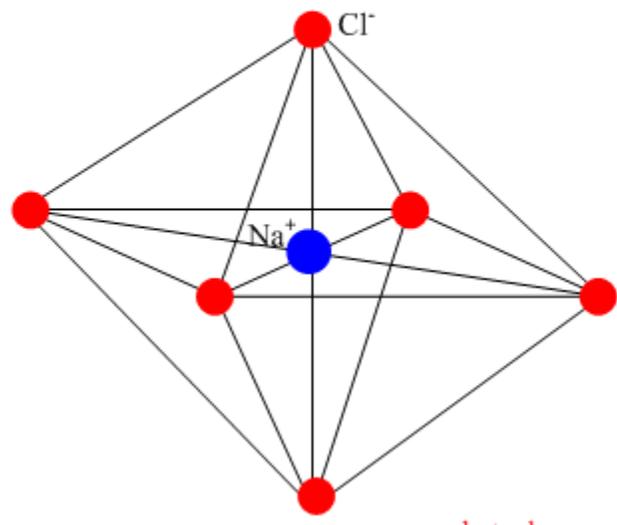
Corundum	Al_2O_3	6-cation CN 4-anion CN	HCP unit cell with O^{2-} anions at the lattice sites and Al^{3+} at interstitial sites
Perovskite	CaTiO_3	6-cation(Ti) CN 2-anion(O) CN	Cubic unit cell with Ti^{4+} cations coordinated octahedrally among six oxygen anions
Silicate	Combination of SiO_4 -blocks	4	Tetrahedral arrangement with Si^{4+} cations at the center bonded to O^{2-} anions at the apices of the tetrahedron

Examples of some ceramic structures

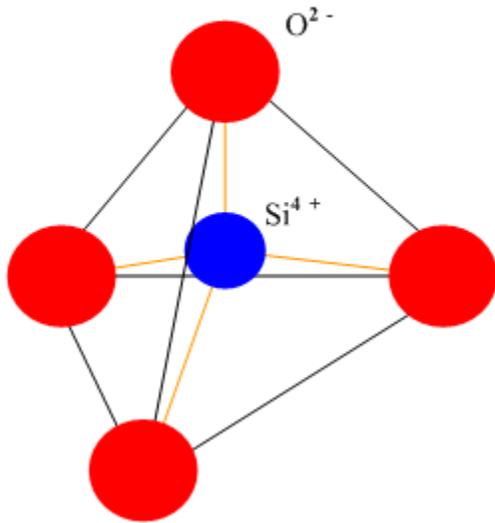
Zincblende (ZnS) Structure



Sodium Chloride (NaCl) Structure



Structure of Silicate Block (SiO_4^{-4})



Tetrahedral silica block (SiO_4^{-4}) may form various silicate structures:

Island and Double Island Silicates

Single or two silica blocks, containing other cations, form Island (olivine) or Double Island Silicates (hemimorphite).

Ring and Chain Structures

Several (3,4,5,6) silica units join each other, forming a chain (orthopyroxenes, clinopyroxenes, asbestos) or closed ring (beryl).

Sheet (layer) structure

Silica units connect to each other, forming infinite sheet (micas, serpentine, chlorite, talc).

Framework silicate

Quartz, cristobalite, and tridymite minerals are based on the framework silicate structure.

Silicates exist in two forms: crystalline and amorphous (glasses).

Source : http://www.substech.com/dokuwiki/doku.php?id=structure_of_ceramic_materials