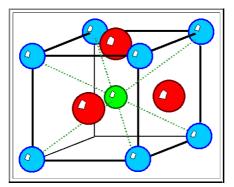
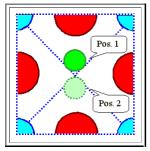
3.6.2 Ferro Electricity

- The name, obviously, has nothing to do with "Ferro" (= Iron), but associates the analogy to ferro magnetism. It means that in some special materials, the electrical dipoles are not randomly distributed, but interact in such a way as to align themselves even without an external field.
 - We thus expect spontaneous polarization and a very large dielectric constant (DK).
 - This should be very useful e.g. for making capacitors but as in the case of ferro magnetism, there are not too many materials showing this behavior.
- The best known material used for many application is BaTiO₃ (Barium titanate).
 - It has a simple lattice as far as materials with three different atoms can have a simple lattice at all. The doubly charged **Ba**²⁺ atoms sits on the corners of a cube, the **O**²⁻ ions on the face centers, and the **Ti**⁴⁺ ion in the center of the cube.
 - We have **8** Ba²⁺ ions belonging to **1/8** to the elementary cell, **6** O²⁻ ions belonging to **1/2** to the elementary cell, and one **Ti⁴⁺** ion belonging in total to the cell, which gives us the **BaTiO₃** stoichiometry.
 - This kind of crystal structure is called a **Perovskite** structure; it is very common in nature and looks like the drawing below (only three of the six oxygen ions are shown for clarity):



Often, the lattice is not exactly cubic, but slightly distorted. In the case of **BaTiO₃** this is indeed the case: The **Ti** - ion does not sit in the exact center of the slightly distorted cube, but slightly off to one side. It thus has two symmetrical positions as schematically (and much exaggeratedly) shown below



Each elementary cell of BaTiO₃ thus carries a dipole moment, and, what's more important, the moments of neighbouring cells tend to line up.

- The interactions between the dipoles that lead to a line-up can only be understood with quantum mechanics. It is not unlike the interactions of spins that lead to ferro magnetism.
 - We will not go into details of ferro electricity at this point. Suffice it to say that there are many uses. Traditionally, many capacitors use ferro-electric materials with high **DK** values. In recent years, a large interest in ferro-electrics for uses in integrated circuits has developed; we have yet to see if this will turn into new products.