E1-07: Effects of V^{5+} doping of TiO_2 on its electrical conductivity

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The alteration of a crystal structure due to doping with altervalent cations can be investigated by studying the electronic conduction properties. The effect of incorporation of V^{5+} ions into the crystal structure of TiO_2 was studied. The doped samples were prepared by the method of high temperature diffusion. Predominently rutile TiO_2 was doped with V^{5+} cations. Both AC and DC electrical conductivity measurements of pure and doped samples were performed. These measurements indicate the alteration in Fermi energy as a result of doping. The conductivity increases (by two orders of magintude) and the activation energy decreases (by ~ 60%) when the sample is doped with V^{5+}.

The defect site reaction:

$$F_2O_5 = 2V[Ti]^{\cdot} + 2\,TiO_2 + \frac{1}{2}O_2(g) + 2e^{-}$$

where Ti^{4+} ion in the lattice point is replaced by V^{5+} and e^{-} is a conduction electron trapped at an oxygen vacancy, explains the increase in n-type semiconductivity due to increase in electron density.

These results are in agreement with the fact that the conductivity increases and the activation energy decreases when TiO_2 is doped with higher (>4) valence cations.