# STUDY OF STRUCTURAL AND MAGNETIC PROPERTIES OF TRANSITION METAL -DOPED $TiO_2$

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## Summary of the work

The aim of this study is to explore the structural and magnetic properties of nanoparticles of 3% and 7% Fe and Cr doped $TiO_2$ prepared by impregnation method. The starting materials taken for the studies are $TiCl_4$ (from which $TiO_2$ is obtained) and nitrates/acetates/chlorides of Fe and Cr. The single phase materials of the desired materials are obtained after sintering the pristine samples at temperatures of $300^oC$. Structural studies of the samples are carried out using X-ray diffractometer. Magnetic properties are studied using the Vibrating Sample Magnetometer.

From the structural studies the average crystallite size of the samples is ~10nm for both the sets of samples, showing no variation as a function of dopant concentration or type. For the Fe doped samples the lattice parameter 'c' increases with increase in doping content. This is attributed to the preferred growth along a certain direction being promoted by the Fe doping. An increase in the cell volume with increase in Fe content is also a reflection of the increase in the 'c' parameter. $TiO_2$ is known to be a diamagnetic material. This is observed from the current study too. Addition of dopants renders the samples paramagnetic. This is because of the contribution of Fe, which acts as a donor. The Fe dopant also gives rise to a complex bonding structure between $Fe^{3+}$, oxygen, $Ti^{4+}$ and oxygen vacancies, which results in a positive response to the applied magnetic field.

In the case of the Cr-doped $TiO_2$ samples just as observed with the behavior of the cell volume variation, the lattice parameters increase initially and then decrease with increase in doping content. This is attributed to the possible non uniform distribution of Cr content within the $TiO_2$ matrix. Addition of dopants like Cr introduces AFM interactions in the samples. This increases with increasing Cr content, viewed as the decrease of slope of the M-H curves. This kind of behavior is attributed to the complex magnetic structure containing $Cr^{3+}$, $Cr^{4+}$, oxygen and oxygen vacancies, which is non uniformly dispersed within the $TiO_2$ matrix.

The study explores the effect of the addition of different types of dopants like Fe, which is known as a predominantly ferromagnetism inducing ion and Cr, which predominantly induces antiferromagnetism. Though there is no drastic change in the overall structure, the magnetic phases which arise as a result of the dopants added and the sample preparation

conditions employed can dictate the magnetic properties of the samples. The studies also shows that with the same type of dopant used, a change in the sample preparation conditions can alter the properties of the samples to obtain desired properties. This study confirms that it is not the nature of the dopants used alone but the sample preparation conditions employed too which can decide the properties of samples.