Abstract

The present thesis describes the development of a fast-slow coincidence setup for the Time Differential Perturbed Angular Correlation (TDPAC) measurements based on $LaBr_3$(Ce) detectors and then, hyperfine study of different physico-chemical phenomena related to group-IVB metal oxides using the above TDPAC spectrometer. The thesis envisages the sensitivity of the present nuclear hyperfine technique TDPAC in order to study chemical matrices in atomic level.

The latest available $LaBr_3$(Ce) scintillation detectors coupled to a fast PM Tube have been used in the above circuit. After coupling the detector-assembly to the coincidence circuit, the characteristics of the detector system has also been studied in order to optimize the best operational condition for the present measurements. This setup was used for the subsequent TDPAC measurements in order to study the different chemical phenomena. The TDPAC study of the pure Ti, Zr and Hf-oxides in bulk has been carried out and it has been extended to nano dimension in order to study the phase transition in pure TiO_2 nanoparticles as well as Ag@TiO_2 core-shell nanoparticles. The study of the doped systems, viz., Mn and Zr-doped TiO_2 system has also been carried out to investigate the metal-metal interaction in atomic scale. The study includes the thermal behaviour of HfO2 in its fiber and thin film forms. In some cases, the experimental results have been corroborated by the theoretical calculations of EFG at ^{181}Ta site using Wien2k code. The nuclear probe used in the present study, i.e., ^{181}Hf/^{181}Ta, falls in the same group and hence, has got the maximum probability to replace the lattice site in any of these three oxides prepared by a soft chemical coprecipitation method along with the probe. Another aspect of TDPAC, viz., the effect of radioactive decay process feeding the γ-γ cascade has also been studied with ^{111}In/^{111}Cd probe in case of pure oxides. In some cases, the present work has confirmed the pre-existing TDPAC data and in some cases, it has delivered several new data in the field of TDPAC.