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The study of materials showing multifunctional properties at room temperature (RT) is a challenging task for material science and of importance for future applications in spin-based electronics. The prediction of a Curie temperature above RT in Mn-doped ZnO [1] started a new field of research, with the aim to investigate magnetism in normally non-magnetic oxides. Despite the enormous experimental and theoretical efforts, the origin of the magnetism in (3d-elements) doped and pure ZnO is still a matter of debate in the scientific community. Calculations showing a vacancy-driven mechanism for the magnetism in ZnO have been proposed [2, 3], but clear experimental evidences for such mechanisms are still lacking.
In the framework of the experiment IS-443 at ISOLDE-CERN, we apply Mössbauer spectroscopy to investigate the magnetic properties in ZnO upon implantation with radioactive 57Mn+ ($T_{1/2}$ = 1.5 min), decaying to the 57mFe Mössbauer state ($T_{1/2}$ = 100 ns). We study the electronic and magnetic configurations of Fe atoms in the ZnO crystals, and the interaction between the Mn/Fe atoms with the defects induced during the implantation process [4]. Our results show that the majority of the Fe atoms are located on Zn sites in a high-spin Fe3+ state at ⊠ 600 K, giving a strong magnetic contribution in ZnO. The formation/annealing of the magnetism in ZnO is interpreted as occurring/disappearing upon the association/dissociation of Mn/Fe complexes with the lattice defects created in the implantation process [4]. We present an overview of our experimental findings focusing on the essential role played by the lattice defects in observing magnetism in ZnO.

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