Fe-implanted 6H-SiC Study by Atom Probe Tomography (APT) : Elaboration of diluted magnetic semiconductors at room temperature.

L. Diallo[1], M. L. Diallo[1], A. Fnidiki[1a], L. Lechevallier[1, 2], F. Cuvilly[1], I. Blum[1], M. Viret[3], M. Marteau[4], D. Eyidi[4], A. Declémy[4]

1. Normandie Univ., INSA Rouen, UNIROUEN, CNRS, GPM, 76800 Rouen, France.

2. Département de GEII, Université de Cergy-Pontoise, rue d'Eragny, Neuville sur Oise, 95031 Cergy-Pontoise, France.

3. Service de Physique de l'Etat Condensé (DSM/IRAMIS/SPEC), UMR 3680 CNRS, Bât. 772, Orme des Merisiers, CEA Saclay, 91191 Gif sur Yvette, France.

4. Institut PPRIME, UPR 3346 CNRS, Université de Poitiers, ENSMA, SP2MI, téléport 2, 11 Bvd M. et P. Curie, 86962 Futuroscope, Chasseneuil, France.

Among the materials of the spintronic, great hopes are placed on the diluted magnetic semiconductors (DMS) [1]. Ion implantation of 3d transition metals in wide band gap semiconductors is a promising route to get Diluted Magnetic Semiconductors (DMS) with high critical temperature T_C. Fe-implanted SiC (a wide band gap semiconductor with low spin-orbit coupling with excellent transport properties) is recognized as a good DMS candidate. Moreover, ion implantation is a standard route of doping in microelectronics industry and the ability for ^{57}Fe implantation allows using Conversion Electron Mössbauer Spectroscopy (CEMS). In our studies, the 6H-SiC substrates have been multi-implanted in order to realize a 2 % at.Fe concentrations plateau approximatively between 20 and 100 nm. This concentration is sufficient to obtain a magnetic effect in the implanted layer. The samples received thermal annealing after implantation at 550°C. We investigated the annealing temperature influence on the material. By using Atom Probe Tomography (APT), we can map the Fe atoms distribution inside the SiC. Figure 1 shows the 3D reconstructions of annealing at 900°C sample where only the Fe atoms are represented. In the sample some clusters clearly appear. It reveals nano-precipitates rich in iron, with a disparity in their size ranging from 1 to 4 nm (the largest). Thanks to the APT technique we can also count the number of Fe atoms in the clusters and in the matrix, determine the core phase what could be used to determine the magnetic contributions of the Fe atoms contained in the clusters and in the matrix. These results correlated to the results obtained by SQUID magnetometry and Mössbauer spectrometry should allowing a better understanding of the magnetic properties of the implanted Fe-SiC.

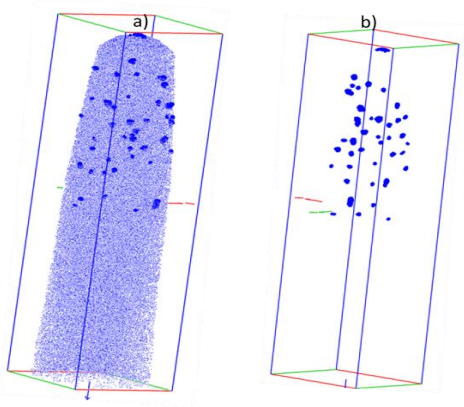

Figure 1: 3D reconstruction of 900°C annealed samples (2 at. % Fe)
a) matrix and precipitates, b) precipitates

[1] T. Dietl, H. ohno, F. Matsuka, J. Cibert, D. ferrand, Science 287 1019 (2000).