Propagation of repressive chromatin marks by PRC2 - how EED recognises histone tails

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The vast majority of the electronic devices today are based on silicon technology and their performance and operation depend on the movement and mobility of electronic charge. This mode of operation sets the limits on power consumption, operation speed and results in potential device overheating, particularly at fast switching speeds. At the same time, it is well-known that electrons also possess a spin and the idea of manipulating this property led to a relatively new field of research - spintronics.One of the goals of spintronics is to combine the magnetic memory storage capabilities of a hard disk with the electronics of a microprocessor in a single chip, leading to smaller and faster devices that require less power. The group of dilute semiconductors with Curie temperatures well in excess of room temperature is one of the most interesting magnetic materials to emerge in the last few years. While the III-V and oxide-based ferromagnetic semiconductors have been well explored the study of magnetism in the technologically important group IV semiconductors has somewhat lagged behind. In earlier studies of Mn-implanted Si [1, 2] it was not clear whether the magnetism was intrinsic or due to new phase and/or cluster formation because of high temperature processing We have performed EXAFS studies and used beamline I18's microfocus capabilities to map Mn distribution in dilute magnetic semiconductor (Mn-doped Si) in order to shed light on the question of possible origins of magnetism in Mn-implanted Si layers. Mapping has indicated the

Uniform distribution of Mn in our samples and confirms TEM results (Fig. 1). This was found to be true for the samples annealed after ion implantation as well as those not subject to the annealing. X-ray absorption spectra of the Mn doped Si samples were collected in the vicinity of the Mn absorption K-edge (6539 eV, Fig. 2). EXAFS spectra of as-prepared and annealed samples were found to be similar and did not change significantly within the studied concentration range of Mn (3%-5%). The near edge region (between 6530 eV and 6630 eV) of the x-ray absorption spectrum was found to be similar to the simulated spectrum of MnSi B20-type structure (Fig. 3). Specifically, close inspection reveals three features in the region below the maximum signal value (so-

called "white line"). These features are particularly obvious in the first derivative of the signal. One can clearly see at least two distinct coordination shells of atoms around Mn in the magnitude of the Fourier-Transform of the k2-weighted absorption fine structures extracted above the Mn edge. Further analysis revealed that the first shell is definitely composed of Si atoms more than 4 in number. Therefore, we can conclude that Si layer does not contain a detectable amount of Mn clusters. This may suggest interstitial Mn in the Si lattice, but we found that the second shell is composed of Mn atoms rather than Si. Multiple scattering EXAFS analysis (with a path length of up to 15 Å, with up to 3 atoms in the path, within a cluster based on MnSi B20 structure) produced the following results for two shell model around Mn (where R – distance, N – number of atoms, 2 – Debye–Waller factor): $R(Mn\text{-}Si) = 2.38(1)$ Å, $N(Si) = 7(1)$, $2(Mn\text{-}Si) = 0.017(4)$ Å2, $R(Mn\text{-}Mn) = 2.95(1)$ Å, $N(Mn) = 2.5(9)$, $2(Mn\text{-}Mn) = 0.005(1)$ Å2. Here numbers in parenthesis are the corresponding errors in the last digits.

The Debye-Waller factor (mean-square relative displacement of atoms) is rather large for the first peak and this is likely to be due to the presence of more than one shell under the peak, but further detailed analysis is limited by the available data range. The interesting result here is that the second shell consists of only Mn atoms. In fact, we found that it was impossible to obtain a satisfactory fit with any other configuration (e. g. Si atoms in second shell).

Thus, the main finding of this work is that we observe neither formation of Mn clusters nor isolated Mn impurities as a result of ion implantation of Si wafers. Instead, results of analysis of EXAFS data confirm that the clusters of MnSi are formed and that these clusters are stable under annealing. EXAFS data suggest that these clusters are likely to be similar to B20 type and/or to MnSi1.7 structures. These clusters are also under tensile strain from the host Si matrix (as can be concluded

80 x 84mm
2.68mg (300dpi)

Figure 1. Structure of EED in complex with trimethylated histone H3 peptide.

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Figure 2. Hydrophobic box of EED (coloured blue) with bound H3K27me3 peptide (yellow). 2Fo-Fc electron density for the four box residues and peptide is shown.

from increased Mn-Mn distances and a consequence of lattice mismatch between Si (a = 5.431 Å) and MnSi (a= 4.558 Å)) which effectively results in negative pressure exerted on the clusters. We believe that this as well as the nanocrystalline nature of the clusters are responsible for increase of Curie temperature above room temperature. However, while some information exists on pressure dependence of magnetic properties on bulk MnSi with B20 type structure, there is no information as to whether this dependency will hold for MnSi nano crystals. There is also little information on magnetic properties of MnSi1.7. We believe that further efforts should be directed towards conducting XMCD experiments at Mn L-edges in Mn-implanted Si. Such experiments would clarify the role of Mn in magnetic properties of Mn-implanted Si. The Debye-Waller factor (mean-square relative displacement of atoms) is rather large for the first peak and this is likely to be due to the presence of more than one shell under the peak, but further detailed analysis is limited by the available data range. The interesting result here is that the second shell consists of only Mn atoms. In fact, we found that it was impossible to obtain a satisfactory fit with any other configuration (e. g. Si atoms in second shell).

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References
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