

Silicon Nanocrystals in SiO₂ Matrix Obtained By Ion Implantation Under Cyclic Dose Accumulation

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Silicon ions were implanted into thin films of silicon oxide obtained by thermal oxidation of silicon wafers in damp oxygen. For the second series of samples silicon implantation was performed into more dense oxide formed by additional anneal in the air. Accumulation of the implantation dose was made either in one step or cyclically and each time after implantation the samples were subjected to the annealing in dry nitrogen. Total implantation dose and complete time of annealing were maintained invariable.

Data for the first series of samples obtained by high-resolution transmission electron microscopy (HREM) demonstrate formation of silicon nanocrystals of ~ 5 nm size in SiO₂ matrix.

X-ray absorption near edge spectra structure (XANES), representing local neighborhood of absorbing atoms was obtained with the use of synchrotron radiation. Two absorption edges are observed in Si L_{2,3} – spectra for the samples with cyclical dose accumulation. The first one is due to elementary silicon while the second edge is related with SiO₂ matrix. Fine structure of the first edge indicates at formation of nanocrystalline silicon nc-Si in SiO₂ matrix.

For both series of the samples cyclical accumulation of the total dose and time of anneal equal to 2 hours resulted in increase of the relative intensity of absorption edge for nanocrystalline silicon. It should be noted that the probability of formation of silicon nanocrystals in more dense oxide is considerably reduced for the samples of 2-nd series.

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