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Title of the thesis: INVESTIGATION OF ION BEAM INDUCED NANOPATTERNING ON SINGLE CRYSTAL SEMICONDUCTORS AND THIN FILMS.

Abstract

InP and Ge nanostructures have been synthesized the by using low (1.5keV) and medium (50 keV and 500keV) energy ion irradiation. The dependence of angle of incidence of the ion beam, ion fluence and ion energy on the nanostructure formation was studied.

It was observed that as the angle is increased from 0° to 63°, the evolution of nanodots to nanoripples took place. The onset angle of ripple formation was found to be 45°. Although, the elongation of the dots started at 23° incidence with respect to surface normal. The dependence of ion fluence on nanostructure formation was studied and using 500 keV Ar ions as the nuclear energy losses of the two energies matches well. The size of the nanodots increases from 45 nm to 109 nm with the ion fluence. The density of nanodots increases with ion fluence and the dots becomes In rich due to preferential sputtering of P. The energy dependence on nanostructure formation on InP have been studied and it was observed that the dot size increases with increase in ion energy and the dependence goes like size of dots ~ $E^{0.14}$. The dots are found to be bigger for the case of higher energy but the main phenomenon behind the process remains the dependence on S_n where the collision cascades formed inside InP due to the ion impact.

The dots are not well separated from each other for the case of Ge. XPS studies indicate the removal of oxide layer from the surface of Ge due to ion bombardment. Simulation of the Ge surface upon increasing the irradiation time have been performed using MATLAB using the existing theoretical models and it also support the formation of pits and dots on Ge surfaces. The ripple formation takes place around 60°. For Ge, chains of nanodots were observed instead of continuous ripples. The energy dependence on nanostructure formation on Ge were studied and it

was observed that the dot size increases with increase in ion energy and the dependence goes like size of dots ~ $E^{0.15}$.

In comparison, it was found that InP is better material for the formation of nanostructures using IBS. This is due to the fact that InP contains two element In and P with different sputtering rates. On irradiation, P leaves the surface early and makes the surface In rich. The In atoms were agglomerated to form dots on the InP surface. The dots were well separated and well defined in case of InP. But Ge being the single material do not form ordered surface nanostructures and the ion irradiation results in the surface roughening due to defect formation. For both the cases InP and Ge, the dot size is found to increases with increases in ion energy.

As an exploratory experiment on thin films, the CdS nanostructures were synthesized using medium energy (350keV) ion irradiation. Therefore, dots formation can take place on thin film samples but further studies need to be performed for better understanding of the results.

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