Towards Spintronics of Antiferromagnetic Semiconductors - Characterization of MnSe on GaAs

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Antiferromagnets are materials that have become popular in the field of spintronics due to their ability to control the spin axis orientation with electrical current. As a result, several magnetic imaging techniques have been developed to detect the reorientation of antiferromagnetic spins. The research on antiferromagnetic spintronics has mainly focused on semimetallic systems or insulating oxides, leaving optical band-gap semiconductors unexplored. In this study, we investigate manganese selenide (MnSe), which has rocksalt structure and potentially uncompensated (111) planes, making it an attractive material for spin axis detection sensitive to uncompesated surfaces. In addition, since it is a wide gap semiconductor, it can be interfaced with a heavy-metal layer with strong spin-orbit interaction (i.e. platinum) to take advantage of the spin Hall magnetoresistance.

In this work, we study the quality of the MBE grown MnSe/GaAs structures with respect to a key factor - temperature of growth. The main tool to determine the quality of the samples was X-ray diffraction (XRD). We measured samples of MnSe/GaAs(001) and MnSe/GaAs(111).

From $2\theta/\omega$ scan of MnSe/GaAs(111) we obtained a lattice constant $a \approx 5.46$ Å, what indicate to rocksalt crystal structure of grown MnSe layers. We compared FWHM of RC scans of MnSe, where the lowest value, indicating the best quality of layer, was $\Delta = 0.6°$ for MnSe/GaAs(111) grown at T = 300 °C, and $\Delta = 0.3°$ for MnSe/GaAs(001) grown at T = 350 °C. We observe crystal twinning of MnSe layer on the MnSe/GaAs(111) samples. Sample grown at T $\geq$ 450 °C degrade which appears in unreliable values of FWHM using XRD.

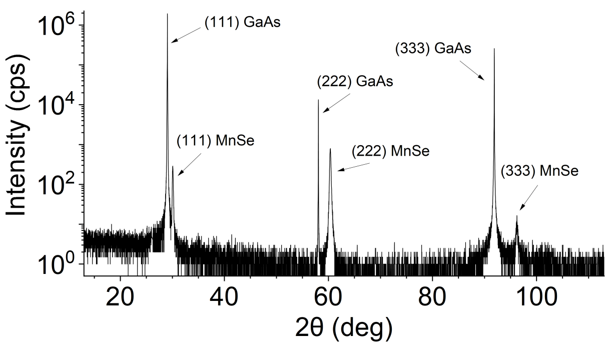

Figure 1: Long range $2\theta/\omega$ scan of MnSe/GaAs(111) sample grown at T = 300 °C.

MnSe/GaAs structures are a good base for the studies of the growth of more complex structures with quantum well having one barrier made of MnSe, which is interesting both in terms of optical experiments as well as magnetotransport when thin layer of platinum is added on the top.

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