CHEMISTRY AND SURFACE ANALYSIS OF GANMN SAMPLES BY OPTICAL AND ELECTRON MICROSCOPY AND BY ENERGY DISPERSIVE SPECTROSCOPY

Jhonattan Rodrigues dos Santos[1], Guilherme Ferreira[1], Douglas Marcel Gonçalves Leite[2], José Humberto Dias da Silva[1] and Americo Tabata[1*]

[1] *Universidade Estadual Paulista, Campus de Bauru, Faculdade de Ciências, Departamento de Física, Bauru/SP Brasil*

[2] *Instituto Tecnológico de Aeronáutica, Departamento de Física, São José dos Campos/SP, Brasil*

1. Introduction

The GaNMn material is one of the most suitable semiconductors for use in spintronics, in which electron spins must be taken in consideration. However, for commercial applications, such material must have a certain content of Mn with a minimum of structural defects. The incorporation of Mn is necessary because these are the atoms those give the magnetic character of the samples. Crystalline defects should always be avoided, as they compromise the performance of devices based on these materials.

The aim of these studies is to analyze the quality of the GaNMn samples surface and to determine the chemical composition of these ones. Also, we would like to observe whether the incorporation of Mn atoms in GaN matrix induces or not structural defects that will create a greater surface roughness.

2. Experimental

The GaNMn samples were prepared by reactive sputtering method on Si substrates.[1] As a reference sample we first prepared a pure GaN film and then successively incorporating Mn elements to form the GaNMn films. To analyze the surface quality and surface roughness of the samples we have used two techniques: a) Confocal Microscopy, which a laser beam scans the sample layer by layer and give us the roughness of the sample, and b) Scanning Electron Microscopy (SEM). In order to determine the chemical composition we have used the technique of *EDS* (Energy dispersive spectroscopy*)*. This technique consists on probing the sample with an electron beam and analysis the emitted X-rays.

3. Results and Discussions

By the results obtained on the confocal microscopy and SEM, we were able to notice that all samples exhibited a surface roughness in the nanometer scale, between 4 and 6 mn. However, it was not observed a straight correlation between roughness and the amount of Mn incorporated on the sample. It is means; there was no substantial increase or decrease in roughness samples by introducing Mn. We also observed on the samples surface the presence of metallic clusters (of the order of hundreds of microns). Up to now, we are not sure if it is same kind Ga droplets or some post-grown contamination. Using the EDS technique it was possible to measure the ratio between the number of Ga and Mn atoms. This ratio ranged from 0 to slightly less than 20, proving the effective incorporation of Mn elements on the samples. Using, in the EDS experiments, excitation energy of 20 kV, it was detected in addition to the gallium and manganese other elements such as nitrogen, silicon, carbon and oxygen. However, when we use a lower excitation energy (10 kV), the elements Si C and O were not detected showing that these ones were located primarily in the Si substrate.

In conclusion**,** we performed optical and electron microscopy and EDS measurements in GaNMn samples prepared by reactive sputtering. We have observed the incorporation of Mn element up to near 20% as compared to the Ga element. We also observed in all the samples a surface roughness of nanometer (~5 nm) scale without, however, having a strait relation with the amount of Mn incorporated.

4. References

[1]- J. H. Dias da Silva, D. M. G. Leite, A. Tabata, A. A. Calheiro, J.Appl.Phys **102**, 063526 (2007).

Acknowledgments

T. P Z. Marques by the measures of SEM and EDS and L. D. Trino by confocal measures. To FAPESP, CNPq and Fundunesp by financial suporte.

*tabata @fc.unesp.br