Growing Ga and In oxide hydroxide nanocrystals on GaAs and InAs crystalline substrates by hot water immersion

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Gallium oxide and gallium oxide hydroxide nanocrystals are potential materials for different applications, e.g. field effect transistors, gas sensors, and solar blind photodetectors [1]. Different methods have been studied for producing Ga_2O_3 and GaOOH nanocrystals [2-4]. On the other hand, GaAs is currently used, e.g. in optoelectronics, but GaAs devices are still suffering from different surface losses, electrical and optical ones. In this work we present a simple method to grow Ga_2O_3 and GaOOH nanocrystals on surface of crystalline GaAs. Our results show that optical losses are reduced on the surface of GaAs after applying this simple method. In order to understand, whether the method can be generalized among different III-V materials, we show that InOOH nanocubes are formed on InAs crystals when proper parameters are used in the method.

In our method, GaAs and InAs wafers are cleaned using wet chemical cleaning methods (HCl+IPA for 3 minutes followed by 1 minute IPA immersion), and then they are immersed into hot water (HW).

Figure 1 shows scanning electron microscopy (SEM) results for GaAs and InAs samples immersed into HW showing that immersion leads to the formation of nanocrystals on both substrates.

Synchrotron grazing incidence X-ray diffraction (GI-SXRD) results (not shown here), confirmed the formation of GaOOH with orthorhombic space group. Also, XPS was measured for Ga 3d core level (not shown here), before and after formation of nanocrystals on GaAs surface. Increased intensity in higher binding energy of Ga 3d shows oxidation of Ga.

PL results (not shown here) show the peak intensity for GaAs is increased by factor of 8 for the sample with nanocrystals compared to the reference sample. On the other hand, reflectance (not shown here) is reduced to half showing a sharper decrease near UV range. These results indicate reduced optical losses after hot water treatment of GaAs surface.

References

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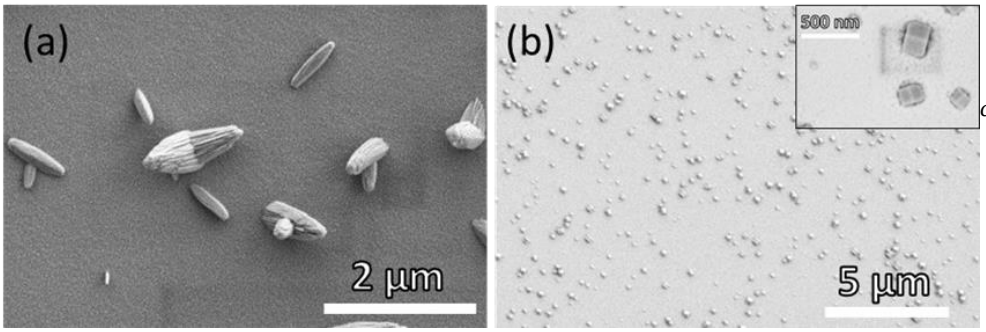

Fig.1: SEM characterization of the hot-water induced nanocrystals on (a) GaAs substrates, and (b) InAs substrate.