Novel three dimensional Ga structures on GaAs (100) substrates obtained by MOVPE.

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Abstract

Novel three dimensional (3D) gallium structures are presented by using commercial organometallics and conventional metal−organic vapour phase epitaxy system (MOVPE). These 3D structures grow up naturally on GaAs substrates and their shapes depend on the growth conditions and principally on the growth temperature.

Introduction

The (Ga, Al, In)N system represents a very important kind of materials for optoelectronic visible devices applications (1). Shortening the size of optoelectronics devices is an important step within the industrial application and its improvement (2).

Gallium metal−organic (TMGa) precursor was used to allow for the growth of these structures. The growth temperature was varied between 500 to 750 °C and the reactor pressure varied between 100 to 760 torr. Nitrogen was utilized as carrier gas. Reactor growth conditions can be found elsewhere and commercial organometallic gallium precursors can be used as well (3).

Results

By using the MOVPE conventional conditions many 3D Ga structures were obtained : montgolfier, cylinder, scepter and cauli−flower like structures (Figure 1). The morphology depends principally on the growth temperature and substrate surface conditions. These structures stick to the substrate by a very thin base. Micrometer structure size can be obtained (.1 to 5 µm diameter). The montgolfier point density at 650 °C is around 10^7 /cm^2. 3D Ga selective growth could also be obtained principally on line substrate defects (fig. 1c).

EDX elemental analysis results show that these 3D structures are mainly gallium composed (fig.2). It should be noticed that, for these experiments, silicon was used as a substrate instead of GaAs in order to get rid of any interference with gallium from the substrate.

Moreover it was evidenced using X−ray diffraction (XRD) that these gallium structures are meta−stable gallium phases as presented in figure 3 (4).

Conclusion

This paper presents the growth and characterization of novel Ga metallic 3D structures, obtained by the conventional MOVPE technique. To support this 3D Ga structures, GaAs (100) substrates were utilized. These 3D structures can be suitable for nitrogen incorporation to obtain GaN like structures (5, 6).

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Figure 1 SEM picture of cauli−flower (a,b at 550 °C) and montgolfier (d,c at 650 °C) 3D gallium structures grown on GaAs (100) substrates. Selectivity can be seen on a substrate defect line on c

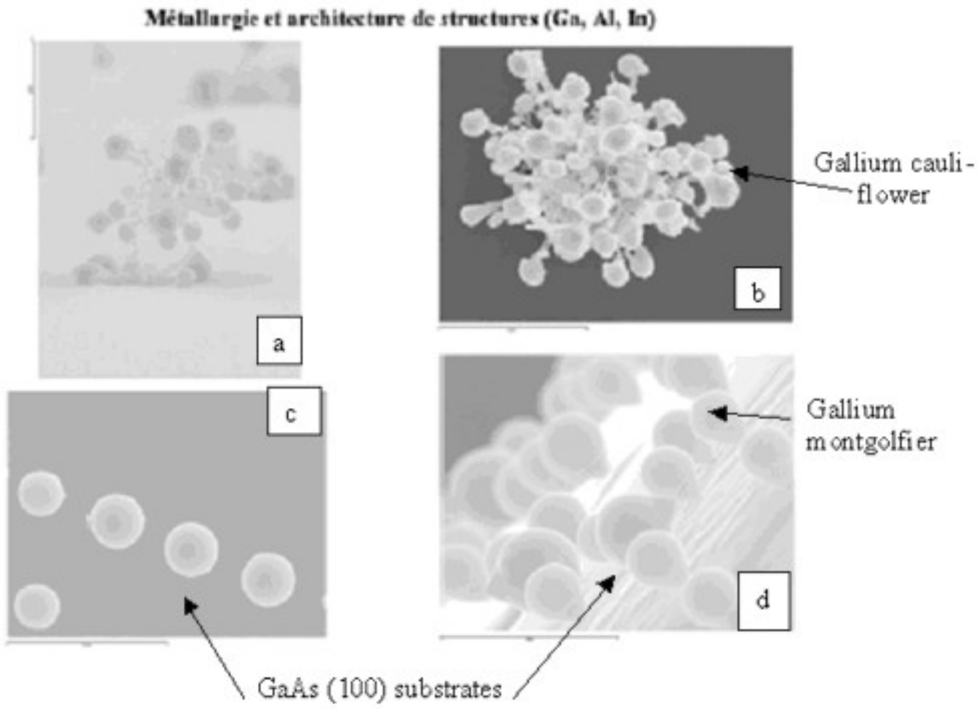

Figure 2. Energy dispersive X−ray analysis (EDX) of a top ball structure. For the composition analysis a Si (100) substrate was used to avoid the GaAs substrate interference. Most of the 3D structure is Ga composed.

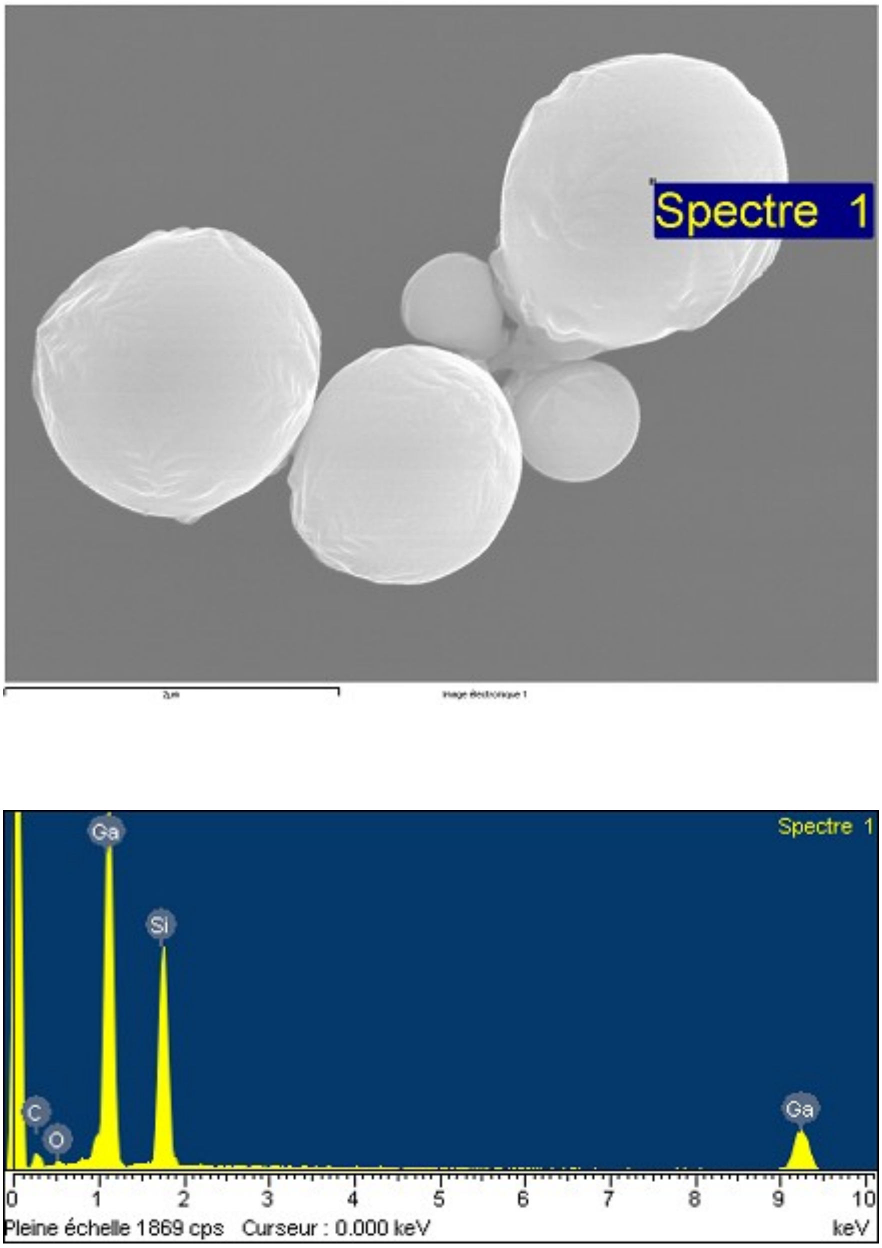

Figure 3: X−Ray grazing angle diffraction (XRD) of Ga montgolfier structures on GaAs substrate, showing the 30−40 two theta region.