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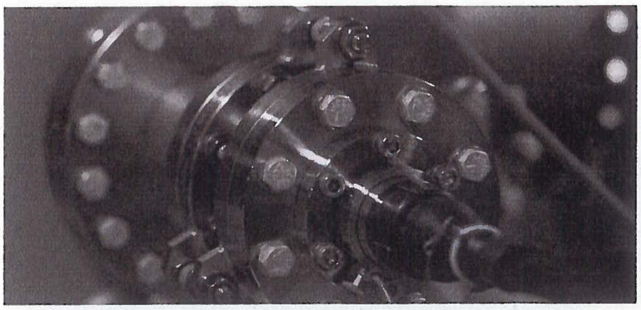

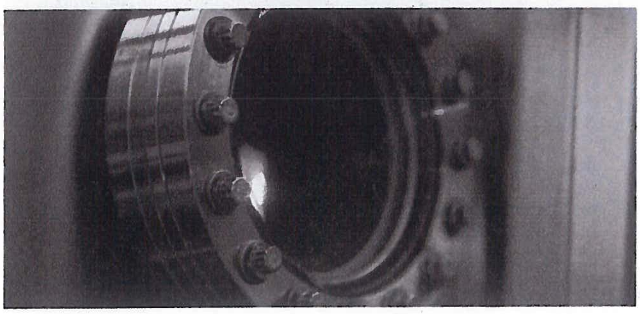

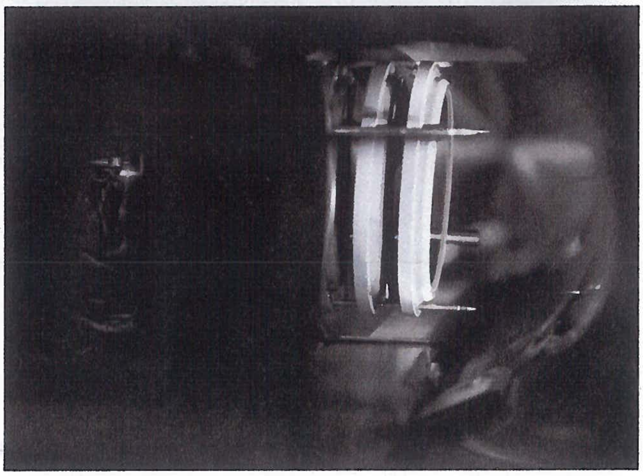

Influence of boron incorporation in GaAs nanowires grown by self-catalysed MBE

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Boron arsenide is a relatively little studied semiconductor with a small lattice constant of 4.78Å. This makes the growth of ternaries such as $B_xGa_{1-x}As$ interesting for strain engineering, since no other III-arsenides cover the same range of lattice constants. However, growth with B is a challenge and has been seen to lead to surface segregation [1] and unintentional doping due to antisite defects [2].

To that end, the incorporation of boron in GaAs nanowires (NWs) was investigated via the growth of GaAs/B:GaAs heterostructure nanowires. GaAs NW stems were grown for 18 minutes via a self-catalysed method, followed by 42 minutes of growth where all parameters were kept constant and in addition boron was supplied from a water-cooled high-temperature effusion cell. The source material was powdered boron of 6N purity, and the BAs growth rate was assumed to be proportional to the cell temperature, as we previously found for layer growth [1].

Figure 1 shows the length distributions of nanowires grown at two different cell temperatures. For comparison, the average length of GaAs nanowires grown for the same total length of time (1 hour) is indicated. Although SEM images indicated the nanowires formed well (inset fig. 1), it is clear that axial nanowire growth was suppressed.

Through post-growth transmission electron microscopy (TEM) analysis of the NWs we found that on all NWs the Ga catalyst droplet had been completely consumed, with a characteristic crystal phase switch from the zinc-blende (ZB) crystal structure of the main NW to wurtzite (WZ) (figure 2). This leads us to hypothesise that the observed reduction in axial growth is due to unintentional droplet consumption leading to sidewall deposition.

We propose that this droplet consumption results from either a reduction in the diffusion length of Ga adatoms in the

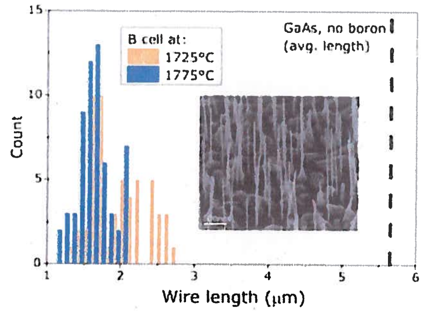

Fig. 1: Histogram of NW lengths for two B:GaAs samples. Average GaAs NW length is indicated for comparison. Inset: SEM image of B:GaAs NWs

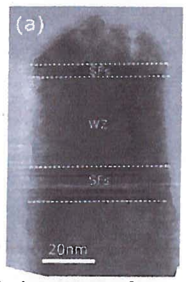

Fig. 2: HRTEM image of consumed droplet. Areas of stacking faults (SFs) and WZ crystal structure are indicated.

presence of B, or to parasitic heating due to the high-temperature B cell, leading to a higher As_4 flux. This has potential implications for the epitaxial MBE growth of all III-V materials containing boron.

[1] H. Detz et al., *J. Cryst. Growth* (2017)
[2] H. Dumont et al, *Appl. Phys. Lett.* **82**, 1830 (2003)

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