

Study of showerhead nozzle configuration in vertical HVPE reactor for large size bulk GaN wafer growth

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Gallium Nitride (GaN) is a promising material which can mostly reduce the electric power conversion loss and help to achieve energy-saving society. It is important to make large size, high quality free-standing GaN wafers. Hydride Vapor Phase Epitaxy (HVPE) has the potential to achieve massive industrialization. For large size homo-epitaxy GaN growth, it is important to control crystal thickness uniformity and crystal shape. We developed new vertical HVPE reactor with facedown wafer holder and showerhead nozzle for large wafer size and long growth time. In the HVPE reactor for 2 inch wafer growth, it's usually single nozzle configuration, but for 4 inch or larger wafer, vertical reactor with multi-nozzles design becomes necessary. In our reactor, an optimized nozzle configuration design was introduced.

The showerhead nozzle configuration of the reactor is shown in Fig. 1. The nozzles on showerhead are separated into In and Out two zones for both GaCl line and NH₃ line, and the flow of each line can be controlled separately. The typical growth condition is at growth temperature of 1058°C, 1 atm, with V/III=20, for 1 hour. Fig.2 shows the crystal thickness distributions along radius from center to edge grown with typical condition but with different flow on each line. With the result, we analyzed thickness contribution of each nozzle zone on showerhead for optimization of in plane thickness distribution. By the aid of HVPE reactor simulation (STR Virtual Reactor), we further demonstrated the analyzation result, besides, with the aid of simulation, we also proposed an optimized nozzle configuration design to eliminate turbulent flow, increase source utilization rate and release parasitic deposition.

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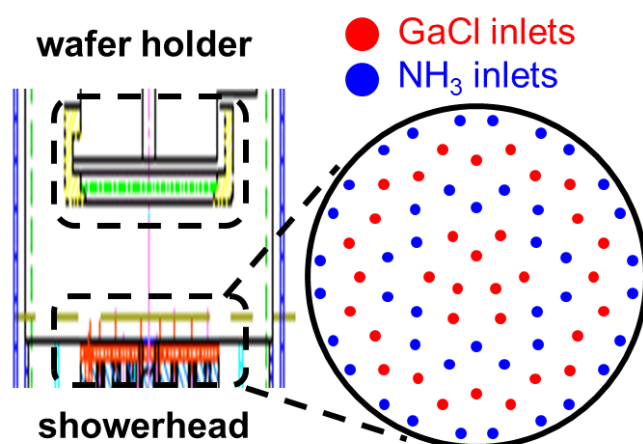


Fig.1 vertical reactor with facedown wafer holder and multi-nozzles showerhead

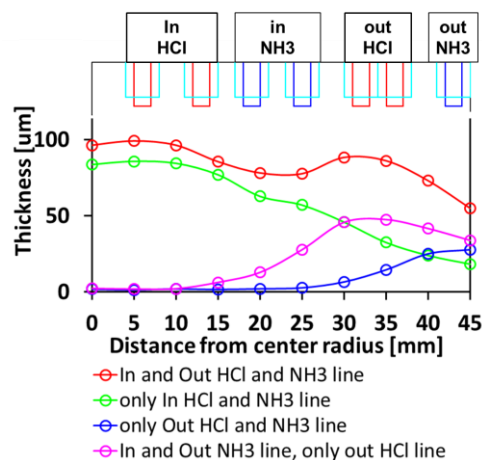


Fig.2 growth rate comparison with gas flow supplied by different lines