Plasma enhanced physical vapor deposition of epitaxial III-V materials (GaN)

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Direct Heteroepitaxy of III-V materials on silicon (Si) has always been a challenge and there are various strategies to integrate these materials. Conventional growth methods like MOCVD and MBE use an additional buffer layer or a nucleation layer and require high temperatures (> 600°C) for the growth [1]. Sputtering, a physical vapor deposition (PVD) technique is a promising approach to grow III-V layers directly on substrates such as sapphire or silicon at low temperature.

Our objective is to grow high quality epitaxial GaN at low temperature using plasma enhanced PVD. In this method, high flux and low energy ion bombardment can be used to increase the crystallinity of the films at low growth temperatures. Further, compared to MOCVD and MBE, PVD is more environmentally friendly and has the potential for large scale production [2].

To achieve GaN epitaxy by RF sputtering system (magnetron), non-toxic gases such as reactive Nitrogen (N_2) and Argon (Ar) are used for processing. Argon (Ar) is used to increase the sputter yield from the target. Liquid Gallium is used as the target.

Although GaN epitaxy on Si is a well-established technology, there are still many unexplored areas, especially when it comes to growth at low temperatures. The major challenge is to be able to grow epitaxial grade GaN via sputtering [3]. What ideal substrate temperature should be used for its growth? What are the growth mechanisms of III-V epitaxy by plasma? The novelty of our research work focuses on answering such questions throughout its tenure.
Modifying the plasma parameters towards an optimized growth of epitaxial GaN is essential. To facilitate the optimization, we will rely on in-situ spectroscopic diagnostics to study the plasma chemistry of Ga, N_2 and Ar.

From an application stand-point, high quality GaN heterostructures have vast potential ranging from multi-junction solar cells to various power electronic devices [4]. With several advantages such as the use of eco-friendly gases, high scalability, low growth temperatures and low cost, plasma enhanced PVD of GaN has the potential of replacing conventional methods in the industry. This work is a step further towards that goal.

In this poster, we will present the main advancements in the development of the GaN reactor and the spectroscopic diagnostics that we aim at developing to analyze both the plasma and the material.

Références

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