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A Simple efficient N atom source for nitride MOCVD based on a dielectric barrier discharge

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MOCVD of nitride thin films such as GaN, TiN, BN have attracted much attention in recent years for optical device, barrier layer, and hard coating applications, respectively. In MOCVD of these materials NH_3 and N_2 are commonly used as a N source gas. However, dissociation of these molecules are difficult due to their strong bonds, and consequently a high substrate temperature and high flux of these gases are required to obtain a reasonable growth rate. In order to enhance the dissociation efficiency of these molecules RF or microwave plasma excitation is often employed, but transport of the activated N-containing radicals onto the substrate surface is difficult because of a relatively low operating pressure of such plasmas.

We report here the design and operation of a simple but efficient remote plasma N atom source for nitride MOCVD based on a dielectric barrier discharge. It can be operated at high pressures, i. e. 10 Torr$\leq$P$\leq$1 atm, so that transport of N atoms generated in the source can be easily delivered to the substrate surface. When the source was operated with a N_2(0.1~10 %)-Ar gas mixture at a few hundred Torr, 100 watt, and a few l/min flow rate, the flow rate of N atom measured by photochemical titration with NO at 10 cm downstream of the plasma region amounted to 10^{16}~10^{18} atoms/sec. To demonstrate the efficiency of the present N atom source, AlN MOCVD has been performed on silicon(100) substrate using trimetylaluminum(TMA). The growth rate as high as 3 um/hr was obtained at a substrate temperature of 600 ℃. The growth rate is found to strongly depend on the N atom flow rate.