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器件制备及器件物理

Al组分对MOCVD制备的$Al_xGa_{1-x}N$/AlN/GaN HEMT电学和结构性质的影响

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摘要： 采用金属有机化合物化学气相沉积（MOCVD）方法制备了不同Al组分（x=0.19，0.22，0.25，0.32）的$Al_xGa_{1-x}N$/AlN/GaN 结构的高电子迁移率晶体管（HEMT）材料。研究了$Al_xGa_{1-x}N$势垒层中Al组分对HEMT材料电学性质和结构性质的影响。研究结果表明，在一定的Al组分范围内，二维电子气（2DEG）浓度和迁移率随着Al组分的升高而增大。然而，过高的Al组分导致HEMT材料表面粗糙度增大，2DEG迁移率降低，该实验现象在另一方面得到了原子力显微镜测试结果的验证。在最佳Al组分（25%）范围内，获得的 HEMT材料的2DEG浓度和室温迁移率分别达到1.2×10^{13} cm^{-2}和1 680 $cm^2/(V\cdot s)$，方块电阻低至310 Ω/□。

关键词： Al组分 AlGaN 高电子迁移率晶体管 电学性质 MOCVD

Influence of Al Composition on Electrical and Structural Properties of $Al_xGa_{1-x}N$/AlN/GaN HEMT Materials Grown by MOCVD

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Abstract: $Al_xGa_{1-x}N$/AlN/GaN high electron mobility transistor (HEMT) materials with different Al compositions (x=0.19, 0.22, 0.25, 0.32) were grown on sapphire substrates by metalorganic chemical vapor deposition (MOCVD). The effects of Al composition on electrical and structural properties of HEMTs materials were analyzed. It is observed that two-dimensional electron gas (2DEG) density and mobility are improved with the raising of Al content within a certain range. However, too high Al composition will make the surface turn to be rougher and the mobility deteriorate, which was reinforced by the test results of atomic force microscopy (AFM). The optimum Al content is 25%. Based on this, the HEMT materials showed a high 2DEG density of 1.2×10^{13} cm^{-2} with a low sheet resistance of 310 Ω/□, and highly Hall mobility of 1 680 $cm^2/(V\cdot s)$ at room temperature.

Keywords: Al composition AlGaN HEMT electrical properties MOCVD

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