

鑽石計畫成果

Improvement of Crystalline Quality and Light Extraction Efficiency in GaN-Based Light-Emitting Diodes by Nanoimprint Lithography

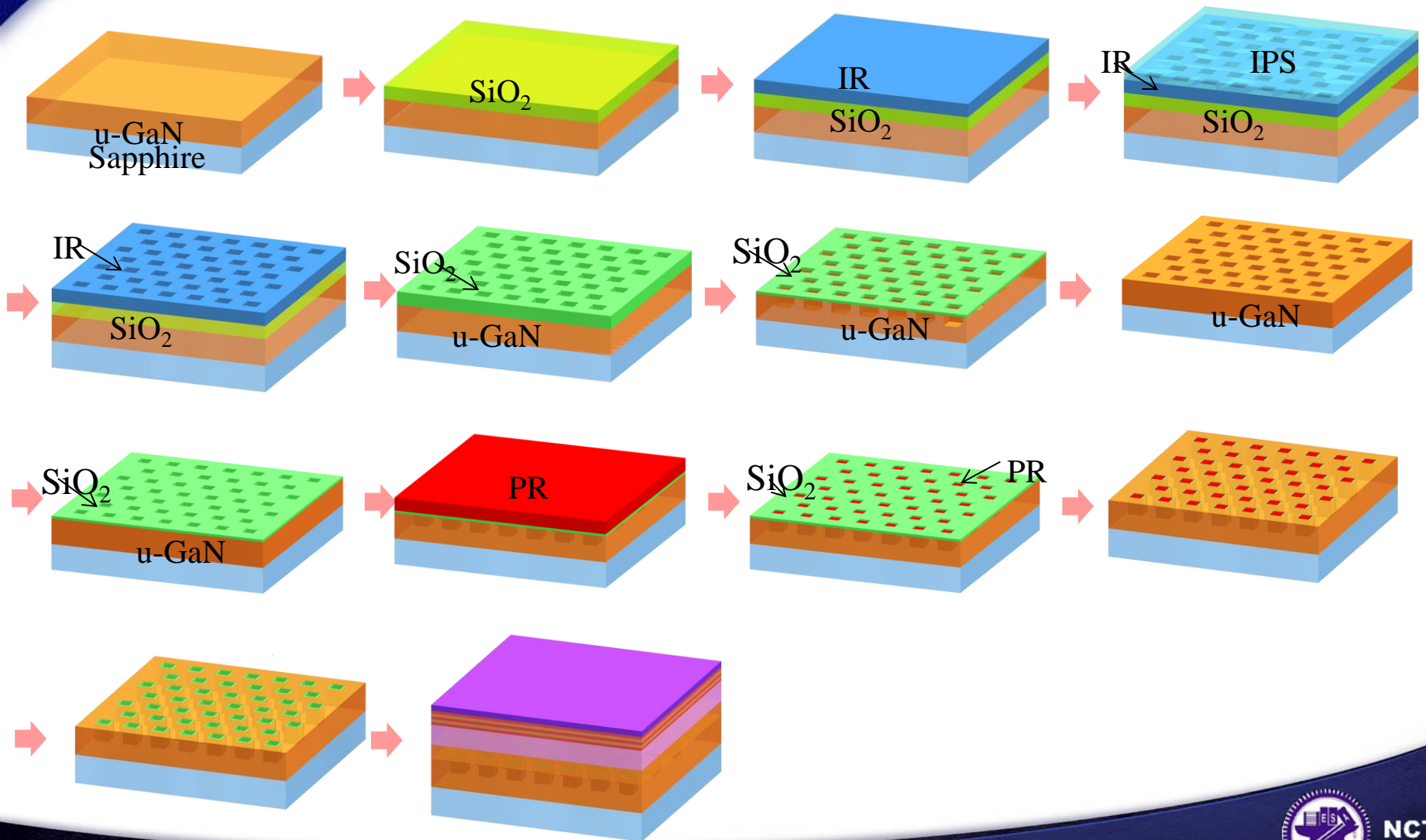
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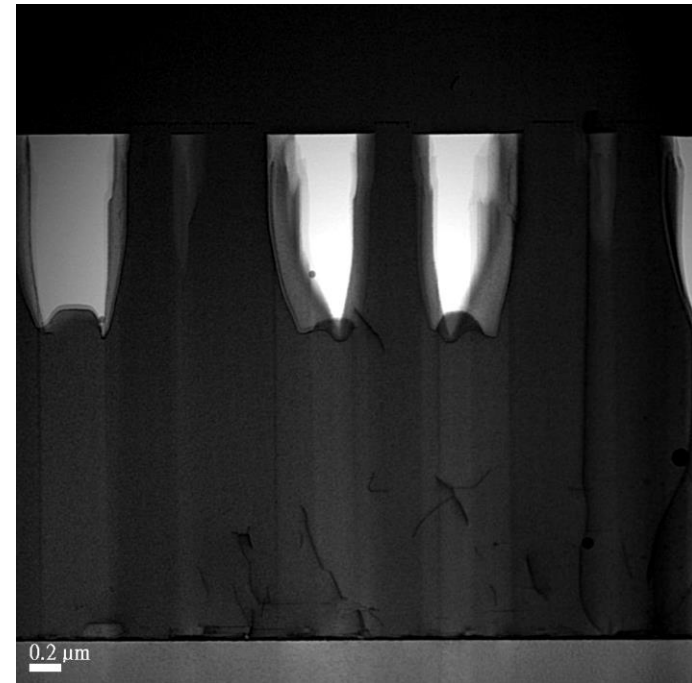
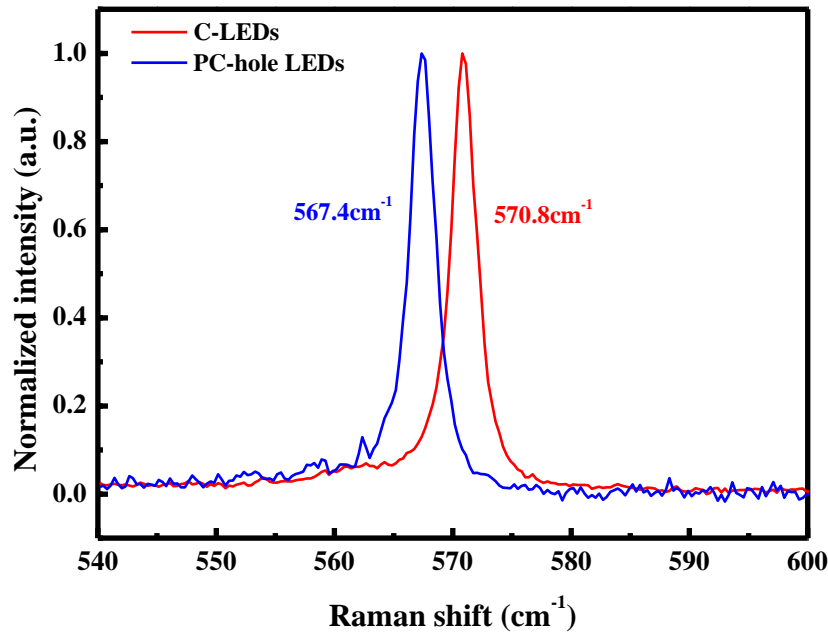


Schematic diagram of process flow





Raman Spectrum & TEM Graph

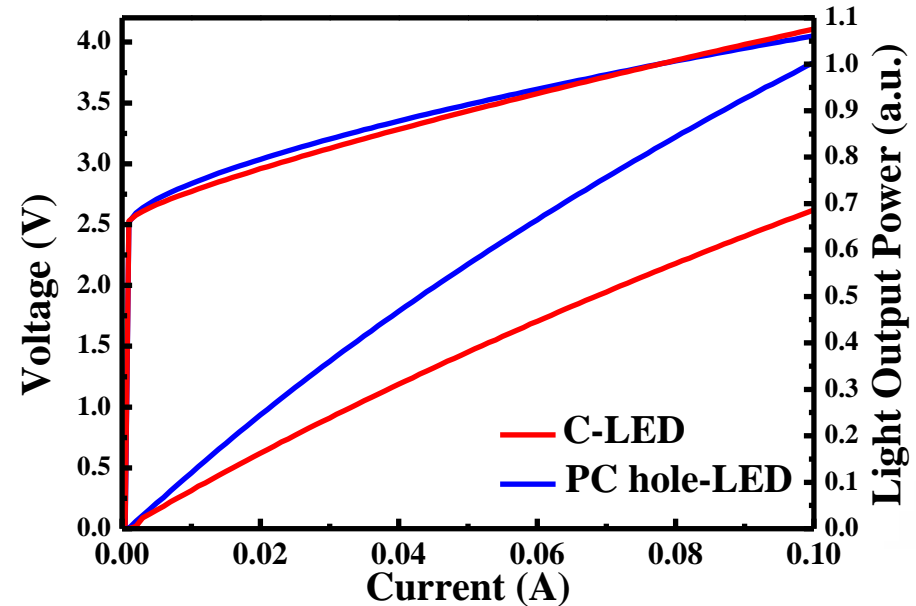
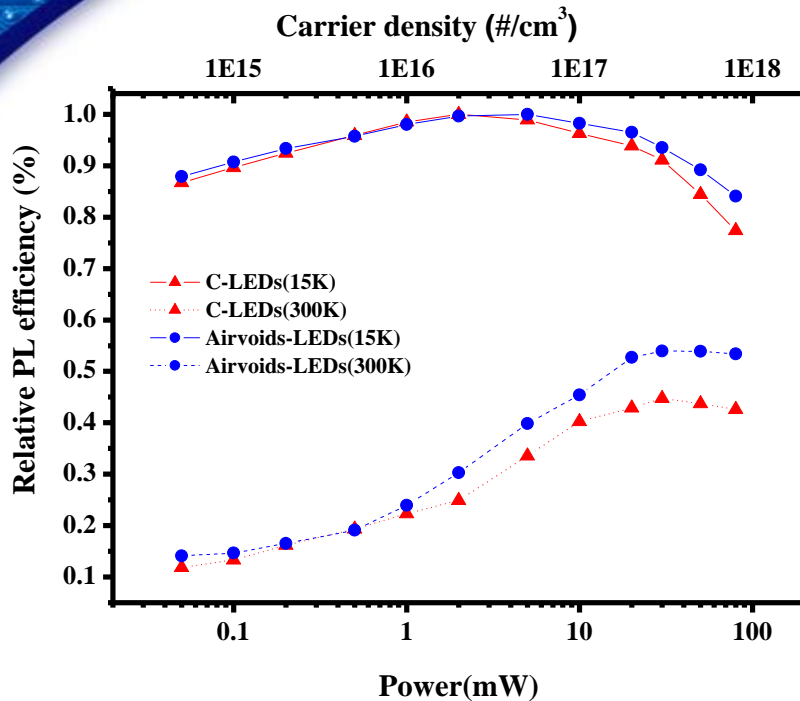


Sample	Strain-free GaN	GaN on Airvoids	GaN on Sapphire
E_2 (high) peak	566.5 cm^{-1}	567.4 cm^{-1}	570.8 cm^{-1}
Compressive Stress	0 GPa	0.22 GPa	1.47 GPa

- The **residual stress** in GaN epilayer grown on air voids structure can be greatly reduced.



IQE & Electronic Characteristics



Sample	airvoids-LEDs	C-LEDs
IQE (%)	53.9%	44.7%

- Light output is enhanced by 45.3% at 20 mA due to the enhancement of IQE and light extraction.

- IQE of air-voids-LEDs is increased by 20.6% compared with C-LEDs due to the higher crystal quality and the lower strain in MQWs.



Summary

- GaN-based LEDs with cubic Airvoids structure were fabricated by nanoimprint lithography (NIL)
- Raman spectrum demonstrated the residual strain of GaN layer was reduced from **1.47 GPa** to **0.22 GPa**.
- TEM images suggested that cubic Airvoids structure can reduce effective stress and TDDs.
- By optical measurement and, we estimated the enhancement of IQE for air-voids-LEDs were **20.3%**, and the light output of airvoids-LED was enhanced by **45.3%** at 20 mA.

