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(54) PENDEOEPITAXIAL METHODS OF FABRICATING GALLIUM NITRIDE SEMICONDUCTOR LAYERS ON SAPPHIRE SUBSTRATES, AND GALLIUM NITRIDE SEMICONDUCTOR STRUCTURES FABRICATED THEREBY

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(56) **References Cited**

U.S. PATENT DOCUMENTS

5,156,995 A 10/1992 Fitzgerald, Jr. et al. 437/90

(List continued on next page.)

FOREIGN PATENT DOCUMENTS

EP 0 852 416 A1 7/1998

(List continued on next page.)

OTHER PUBLICATIONS

International Search Report, PCT/US99/04346, Jun. 9, 1999.

(List continued on next page.)

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(57) **ABSTRACT**

More specifically, gallium nitride semiconductor layers may be fabricated by etching an underlying gallium nitride layer on a sapphire substrate, to define at least one post in the underlying gallium nitride layer and at least one trench in the underlying gallium nitride layer. The at least one post includes a gallium nitride top and a gallium nitride sidewall. The at least one trench includes a trench floor. The gallium nitride sidewalls are laterally grown into the at least one trench, to thereby form a gallium nitride semiconductor layer. However, prior to performing the laterally growing step, the sapphire substrate and/or the underlying gallium nitride layer is treated to prevent growth of gallium nitride from the trench floor from interfering with the lateral growth of the gallium nitride sidewalls of the at least one post into the at least one trench.

17 Claims, 11 Drawing Sheets