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(54) **METHODS OF FABRICATING GALLIUM NITRIDE MICROELECTRONIC LAYERS ON SILICON LAYERS AND GALLIUM NITRIDE MICROELECTRONIC STRUCTURES FORMED THEREBY**

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(51) **Int. Cl.**[7] **H01L 21/20**
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(58) **Field of Search** 438/46, 478, 603, 438/481, 503, 507, 658, 605, 606, 607, 674; 257/76, 94, 96, 103

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(57) **ABSTRACT**

A gallium nitride microelectronic layer is fabricated by converting a surface of a (111) silicon layer to 3C-silicon carbide. A layer of 3C-silicon carbide is then epitaxially grown on the converted surface of the (111) silicon layer. A layer of 2H-gallium nitride then is grown on the epitaxially grown layer of 3C-silicon carbide. The layer of 2H-gallium nitride then is laterally grown to produce the gallium nitride microelectronic layer. In one embodiment, the silicon layer is a (111) silicon substrate, the surface of which is converted to 3C-silicon carbide. In another embodiment, the (111) silicon layer is part of a Separation by IMplanted OXygen (SIMOX) silicon substrate which includes a layer of implanted oxygen that defines the (111) layer on the (111) silicon substrate. In yet another embodiment, the (111) silicon layer is a portion of a Silicon-On-Insulator (SOI) substrate in which a (111) silicon layer is bonded to a substrate. Lateral growth of the layer of 2H-gallium nitride may be performed by Epitaxial Lateral Overgrowth (ELO) wherein a mask is formed on the layer of 2H-gallium nitride, the mask including at least one opening that exposes the layer of 2H-gallium nitride. The layer of 2H-gallium nitride then is laterally grown through the at least one opening and onto the mask. A second, offset mask also may be formed on the laterally grown layer of 2H-gallium nitride and a second laterally grown layer of 2H-gallium nitride may be overgrown onto the offset mask. Lateral growth of the layer of 2H-gallium nitride also may be performed using pendeoepitaxial techniques wherein at least one trench and/or post is formed in a layer of 2H-gallium nitride to define at least one sidewall therein. The layer of 2H-gallium nitride is then laterally grown from the at least one sidewall. Pendeoepitaxial lateral growth preferably continues until the laterally grown sidewalls coalesce on the top of the posts or trenches. The top of the posts and/or the trench floors may be masked to promote lateral growth and reduce nucleation and vertical growth.

53 Claims, 20 Drawing Sheets