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(54) **M<sup>III</sup>N BASED MATERIALS AND METHODS AND APPARATUS FOR PRODUCING SAME**

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(57) **ABSTRACT**

A high deposition rate sputter method is utilized to produce bulk, single-crystal, low-defect density Group III nitride materials suitable for microelectronic and optoelectronic devices and as substrates for subsequent epitaxy, and to produce highly oriented polycrystalline windows. A template material having an epitaxial-initiating growth surface is provided. A Group III metal target is sputtered in a plasma-enhanced environment using a sputtering apparatus comprising a non-thermionic electron/plasma injector assembly, thereby to producing a Group III metal source vapor. The Group III metal source vapor is combined with a nitrogen-containing gas to produce a reactant vapor species comprising Group III metal and nitrogen. The reactant vapor species is deposited on the growth surface to produce a single-crystal M<sup>III</sup>N layer thereon. The template material is removed, thereby providing a free-standing, single-crystal M<sup>III</sup>N article having a diameter of approximately 0.5 inch or greater and a thickness of approximately 50 microns or greater.

**49 Claims, 15 Drawing Sheets**

