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**Linthicum et al.**

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(54) **GALLIUM NITRIDE SEMICONDUCTOR STRUCTURES FABRICATED BY PENDEOEPITAXIAL METHODS OF FABRICATING GALLIUM NITRIDE SEMICONDUCTOR LAYERS ON WEAK POSTS**

EP 0 551 721 A2 7/1993  
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*Primary Examiner*—David Nelms

*Assistant Examiner*—David Vu

(74) *Attorney, Agent, or Firm*—Moore & Van Allen PLLC; Steven B. Phillips

(75) **Inventors:** **Kevin J. Linthicum**, Angier, NC (US); **Thomas Gehrke**, Carrboro, NC (US); **Robert F. Davis**, Raleigh, NC (US)

(73) **Assignee:** **North Carolina State University**, Raleigh, NC (US)

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(57) **ABSTRACT**

A gallium nitride layer is pendeoepitaxially grown on weak posts on a substrate that are configured to crack due to a thermal expansion coefficient mismatch between the substrate and the gallium nitride layer on the weak posts. Thus, upon cooling, at least some of the weak posts crack, to thereby relieve stress in the gallium nitride semiconductor layer. Accordingly, low defect density gallium nitride semiconductor layers may be produced. Moreover, the weak posts can allow relatively easy separation of the substrate from the gallium nitride semiconductor layer to provide a freestanding gallium nitride layer. The weak posts may be formed by forming an array of posts in spaced apart staggered relation on the substrate. By staggering the posts, later fracturing may be promoted compared to long unstaggered posts. Alternatively, the posts may have a height to width ratio in excess of 0.5, so that the relatively narrow posts promote cracking upon reduction of the temperature. In another alternative, the posts preferably are less than one micron wide, more preferably less than one half micron wide, regardless of height, to promote cracking. In yet another alternative, a post weakening region is formed in the posts, adjacent the substrate. In particular, a buried region may be formed in the substrate and the substrate then may be selectively etched to define the plurality of weak posts including the post weakening regions that comprise the buried region. The buried region may comprise implanted ions, preferably hydrogen ions, that can form hydrogen bubbles within the posts that can fracture the posts upon cooling.

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(51) **Int. Cl.<sup>7</sup>** ..... **H01L 33/00**

(52) **U.S. Cl.** ..... **257/103; 438/503**

(58) **Field of Search** ..... 438/478-479, 438/492, 503, 938, 46, 603, 481, 507, 658, 605-607, 674; 257/76, 94, 96, 103

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**59 Claims, 5 Drawing Sheets**

