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# United States Patent [19]

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Liu et al.

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[54] **METHOD FOR FORMING A DIAMOND COATED FIELD EMITTER AND DEVICE PRODUCED THEREBY**

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[73] Assignee: **North Carolina State University**, Raleigh, N.C.

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[21] Appl. No.: **380,079**

Geis, et al., *Diamond Cold Cathodes*, Elsevier Science Publishers B. V., 1991, pp. 309-310.

[22] Filed: **Jan. 30, 1995**

Liu, et al., *Diamond Thin Film Coated Si Field Emitters*, NCSU Research Adm., Sep. 2, 1994, pp. 8-11.

### Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 937,481, Aug. 28, 1992, Pat. No. 5,397,428, which is a continuation-in-part of Ser. No. 811,425, Dec. 20, 1991, abandoned.

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[51] Int. Cl.<sup>6</sup> ..... **C30B 29/04**

[52] U.S. Cl. .... **117/86; 117/95; 117/103; 117/929; 427/577**

[58] Field of Search ..... 117/86, 929, 95, 117/103; 427/577; 357/56; 313/495

### [57] ABSTRACT

A method for making a field emitter comprising the steps of providing a projection; electrically biasing the projection; and exposing the electrically biased projection to a hydrocarbon containing plasma to form a layer of diamond nuclei on the projection. The diamond nuclei are relatively inert and have a high nucleation density. The projection is preferably a material capable of forming a carbide, such as (111) oriented silicon. Refractory metals may also be used for the projection. The electrical biasing is preferably at a voltage in a range of about -150 to -250 volts. The hydrocarbon containing plasma preferably comprises a plasma including about 2 to 5% by weight of methane in hydrogen. An intervening carbide layer is preferably formed at a surface of the projection and underlying the layer of diamond nuclei. The field emitter produced by the method and having a relatively high diamond nucleation density is also disclosed.

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**49 Claims, 5 Drawing Sheets**

