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Saito et al.

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(54) **THIN FILMS AND A METHOD FOR PRODUCING THE SAME**

2002/0170495 A1 11/2002 Nakamura et al.

(75) Inventors: **Takao Saito**, Nagoya (JP); **Yukinori Nakamura**, Nagoya (JP); **Yoshimasa Kondo**, Nagoya (JP); **Naoto Ohtake**, Yokosuka (JP)

FOREIGN PATENT DOCUMENTS

DE	195 13 614 C1	10/1996
DE	100 55 609 A1	5/2002
JP	H9-104985	4/1997
JP	09-259431	10/1997
JP	11-12735	* 1/1999
JP	11-256331	9/1999
JP	2001-220681	8/2001

(73) Assignee: **NGK Insulators, Ltd.**, Nagoya (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 802 days.

This patent is subject to a terminal disclaimer.

(Continued)

OTHER PUBLICATIONS

(21) Appl. No.: **10/774,454**

Mizuno et al., Characterization of Ultra-short Pulsed Discharge Plasma for CVD Processing, IEEE Transaction on Industry Applications, Volu 29, No. 3 May/Jun. 1993. pp. 656-660.*

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Primary Examiner—David Turocy
(74) *Attorney, Agent, or Firm*—Burr & Brown

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(57) **ABSTRACT**

(51) **Int. Cl.**

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An object of the present invention is to provide a method of forming a thin film of excellent quality by generating discharge plasma using gaseous raw material including a carbon source under an atmosphere of a relatively high pressure of 100 Torr or higher. A substrate 6 is mounted on at least one of opposing electrodes 4 and 5. A pulse voltage is applied on the opposing electrodes 4 and 5 under a pressure of 100 to 1600 Torr in an atmosphere containing gaseous raw material "A" including a carbon source to generate discharge plasma. A thin film 7 is thus formed on the substrate 6. The pulse voltage has a pulse duration of 10 to 1000 nsec.

(52) **U.S. Cl.** 427/569; 427/249.1; 427/249.7

(58) **Field of Classification Search** 427/569, 427/249.7, 902, 906

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,711,814 A 1/1998 Mori

4 Claims, 4 Drawing Sheets

