United States Patent [19]

Chiang et al.

[11] **Patent Number: 6,139,699**

[45] **Date of Patent: *Oct. 31, 2000**

[54] **SPUTTERING METHODS FOR DEPOSITING STRESS TUNABLE TANTALUM AND TANTALUM NITRIDE FILMS**

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[73] Assignee: **Applied Materials, Inc.**, Santa Clara, Calif.

[*] Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

[21] Appl. No.: **08/863,451**

[22] Filed: **May 27, 1997**

[51] **Int. Cl.^{7}** **C23C 14/34**

[52] **U.S. Cl.** **204/192.15**; 204/192.12; 204/192.13; 204/192.22

[58] **Field of Search** 204/192.12, 192.13, 204/192.15, 298.12, 192.22, 298.13; 347/203; 438/685

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,607,384	9/1971	Banks	117/215
3,763,026	10/1973	Cordes	204/192
4,000,055	12/1976	Kumagai	204/192
4,036,708	7/1977	Feit et al.	204/38 A
4,683,043	7/1987	Melton et al.	204/192.15
5,186,718	2/1993	Tepman et al.	29/25.01
5,236,868	8/1993	Nulman	437/190
5,464,711	11/1995	Mogab et al.	430/5
5,491,505	2/1996	Suzuki et al.	347/203
5,540,820	7/1996	Terakado et al.	204/192.15
5,643,834	7/1997	Harada et al.	437/210
5,834,374	11/1998	Cabral, Jr. et al.	438/685

FOREIGN PATENT DOCUMENTS

0346828	12/1989	European Pat. Off.	G03F 1/00
0644535	3/1995	European Pat. Off.	G11B 5/60
WO 9704143	2/1997	WIPO	C23C 16/30

OTHER PUBLICATIONS

S.M. Rossnagel and J. Hopwood, "Metal ion deposition from ionized mangetron sputtering discharge" J. Vac. Sci. Technol. B, vol. 12, No. 1, Jan./Feb. 1994, pp. 449–453.

S.M. Rossnagel, et al. "Thin, high atomic weight refractory film deposition for diffusion barrier, adhesion layer, and seed layer applications" J. Vac. Sci. Technol. B, 14(3), May/Jun. 1996.

Kyung–Hoon Min et al. "Comparative study of tantalum and tantalum nitrides (Ta_2N and TaN) as a diffusion barrier for Cu metalization" J. Vac. Sci Technol. B 14(5), Sep./Oct. 1996.

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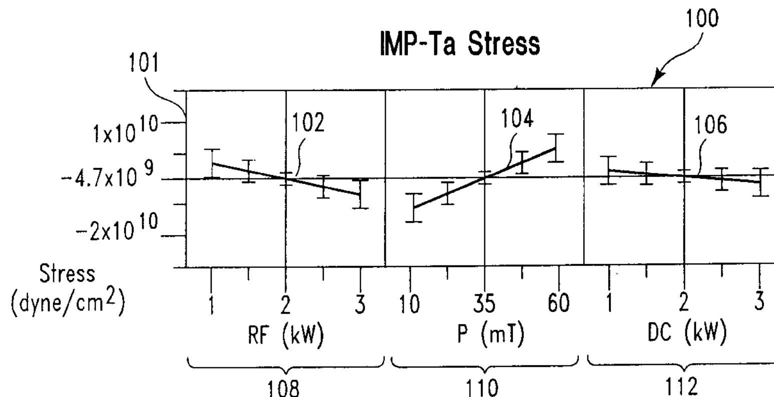
[57] **ABSTRACT**

The present disclosure pertains to our discovery that residual stress residing in a tantalum film or tantalum nitride film can be controlled (tuned) by controlling particular process variables during film deposition. By tuning individual film stresses within a film stack, it is possible to balance stresses within the stack. Process variables of particular interest include: power to the sputtering target; process chamber pressure (i.e., the concentration of various gases and ions present in the chamber); substrate DC offset bias voltage (typically an increase in the AC applied substrate bias power); power to an ionization source (typically a coil); and temperature of the substrate upon which the film is deposited. The process chamber pressure and the substrate offset bias most significantly affect the film tensile and compressive stress components, respectively. The most advantageous tuning of a sputtered film is achieved using high density plasma sputter deposition, which provides for particular control over the ion bombardment of the depositing film surface. When the tantalum or tantalum nitride film is deposited using high density plasma sputtering, power to the ionization source can be varied for stress tuning of the film. We have been able to reduce the residual stress in tantalum or tantalum nitride films deposited using high density plasma sputtering to between about $6\times10^{+9}$ dynes/cm^2 and about $-6\times10^{+9}$ dynes/cm^2 using techniques described herein. The tantalum and tantalum nitride films can also be tuned following deposition using ion bombardment of the film surface and annealing of the deposited film.

14 Claims, 4 Drawing Sheets



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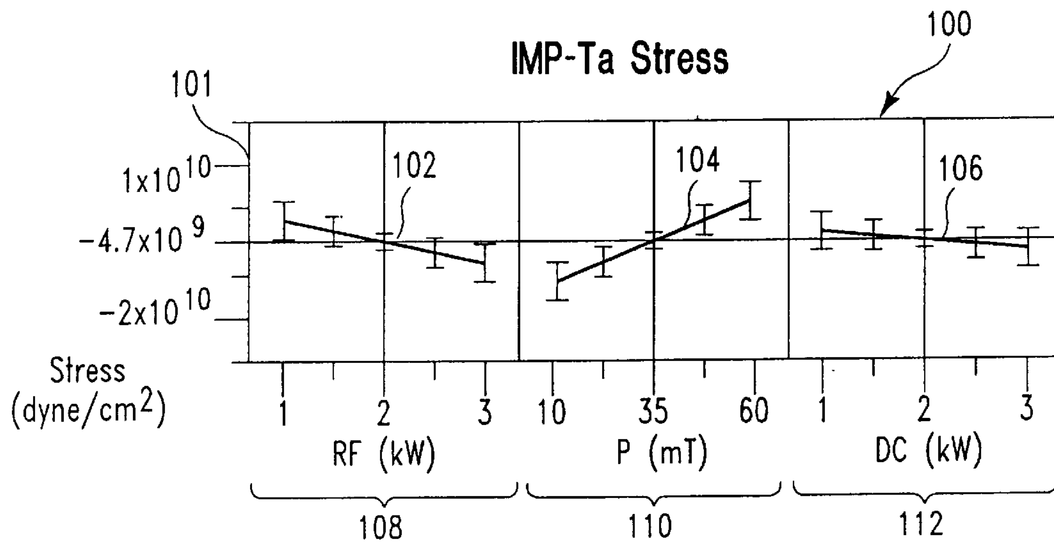

FIG. 1

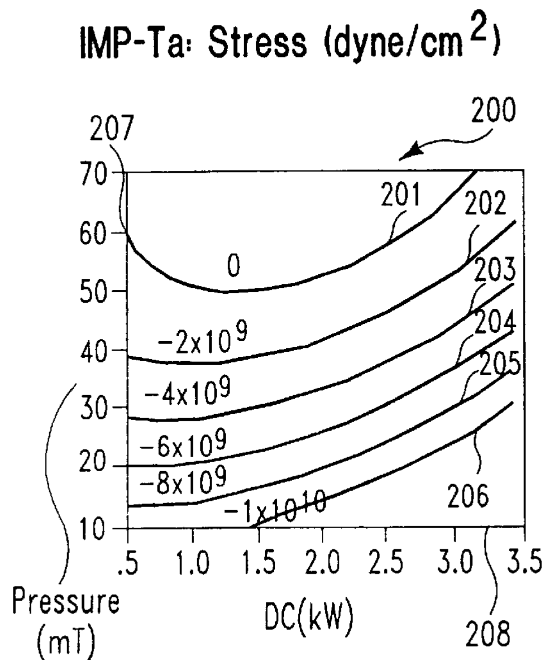

FIG. 2A

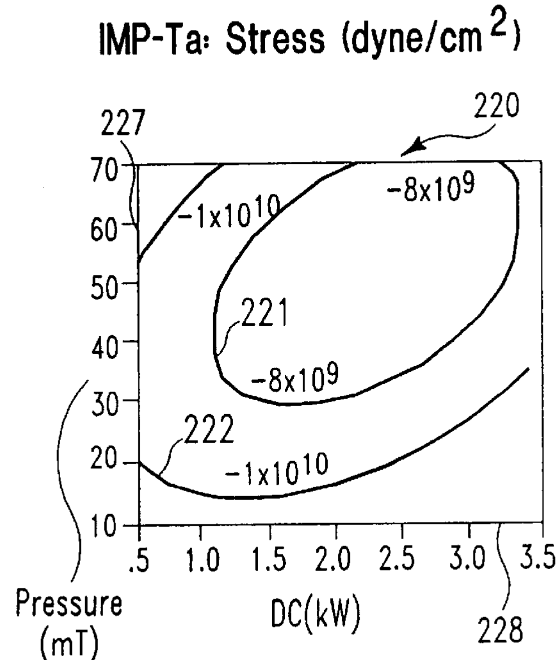

FIG. 2B

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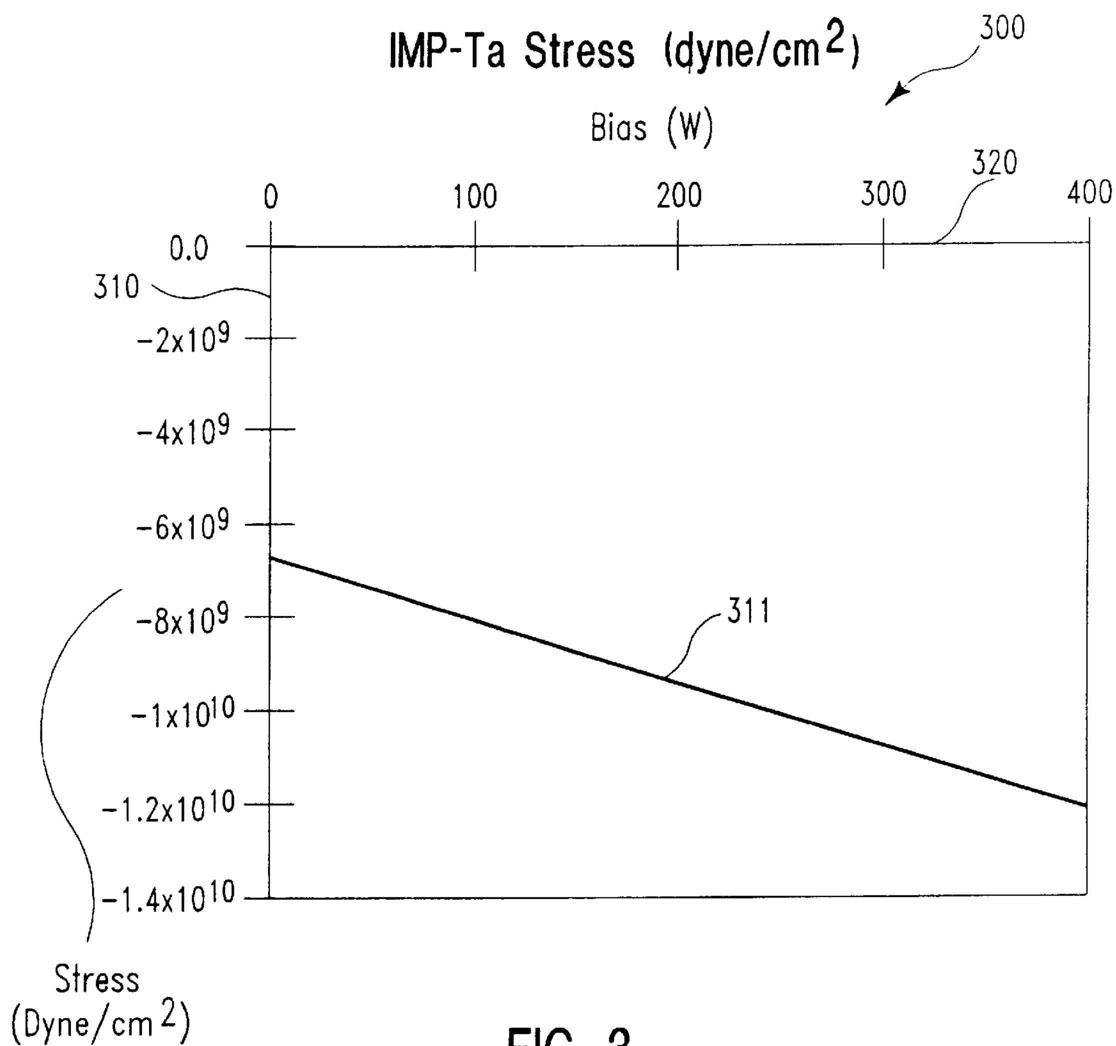

FIG. 3

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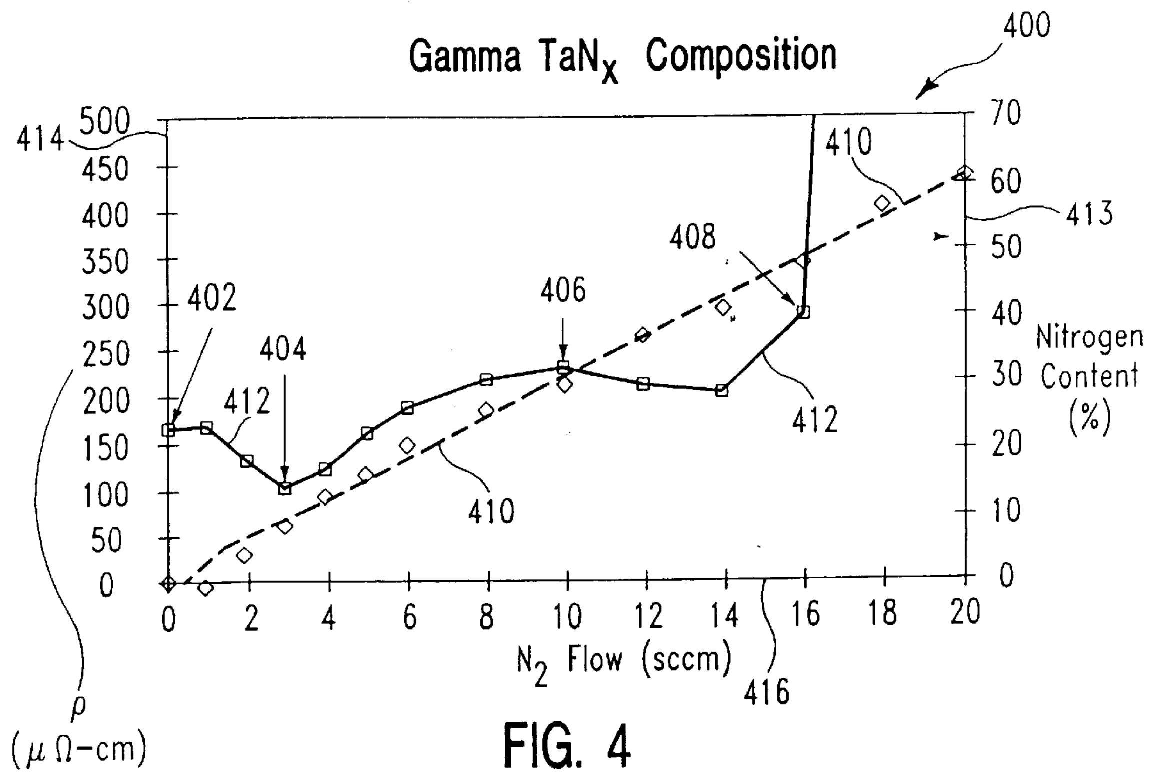

FIG. 4

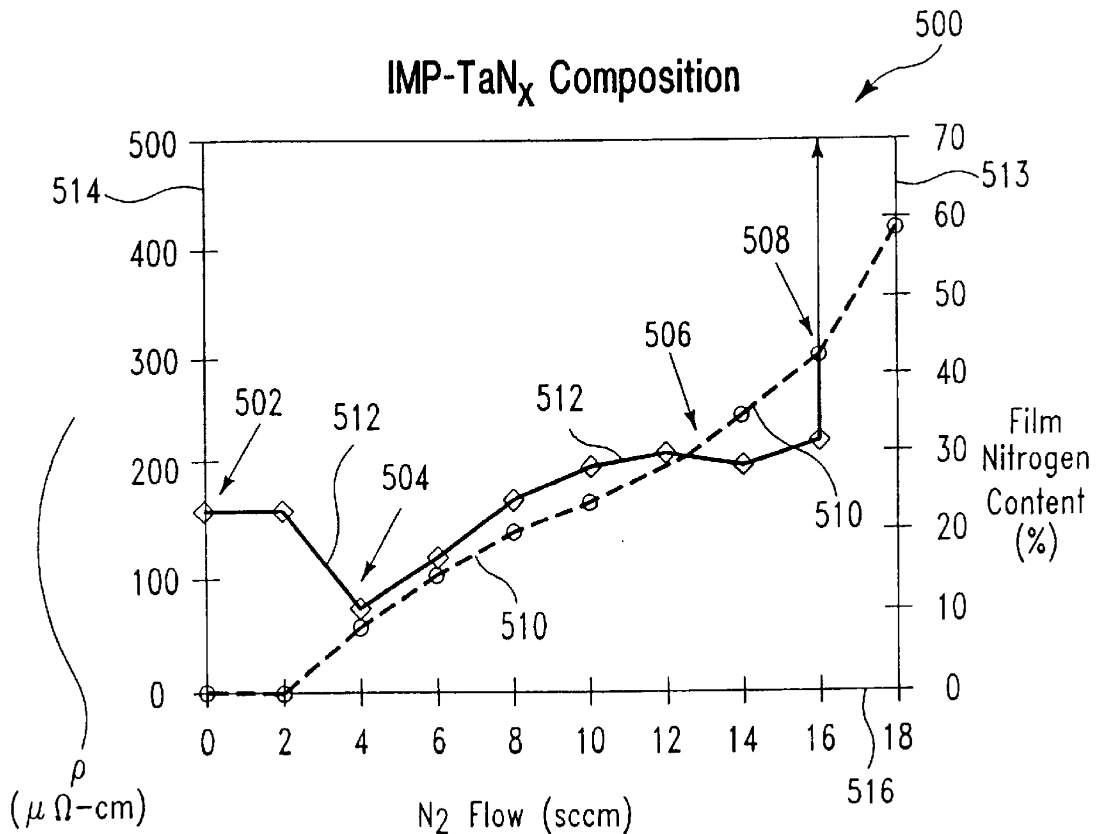

FIG. 5

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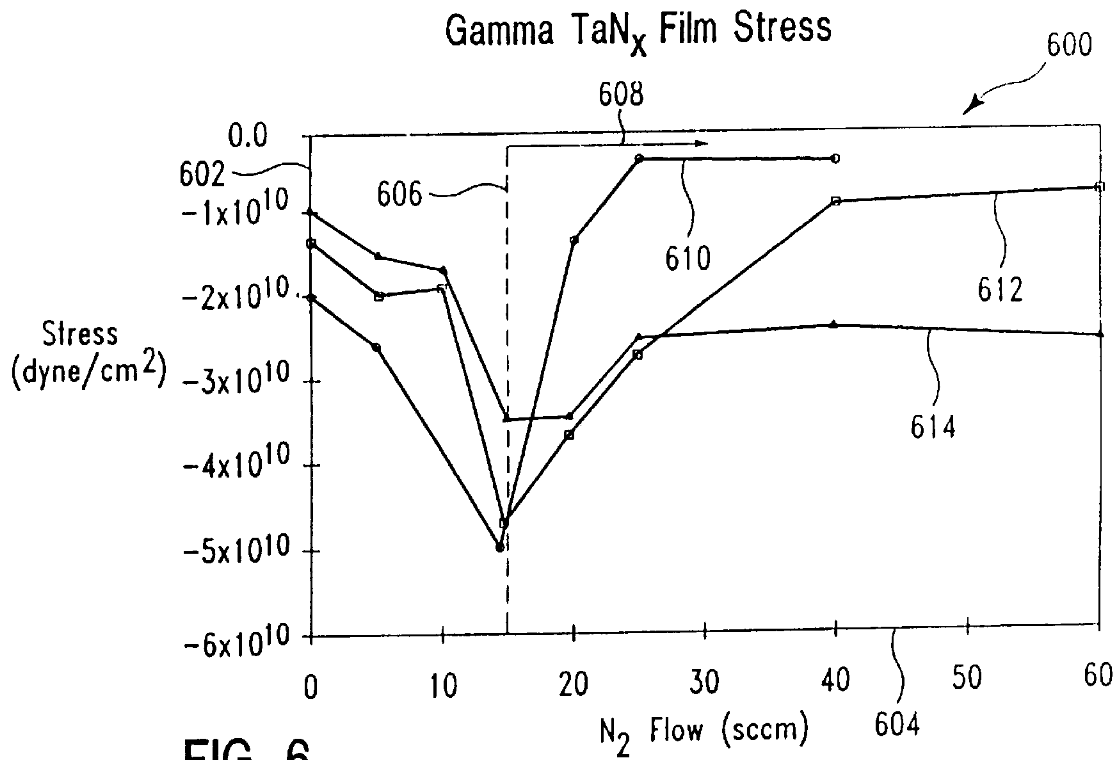

FIG. 6

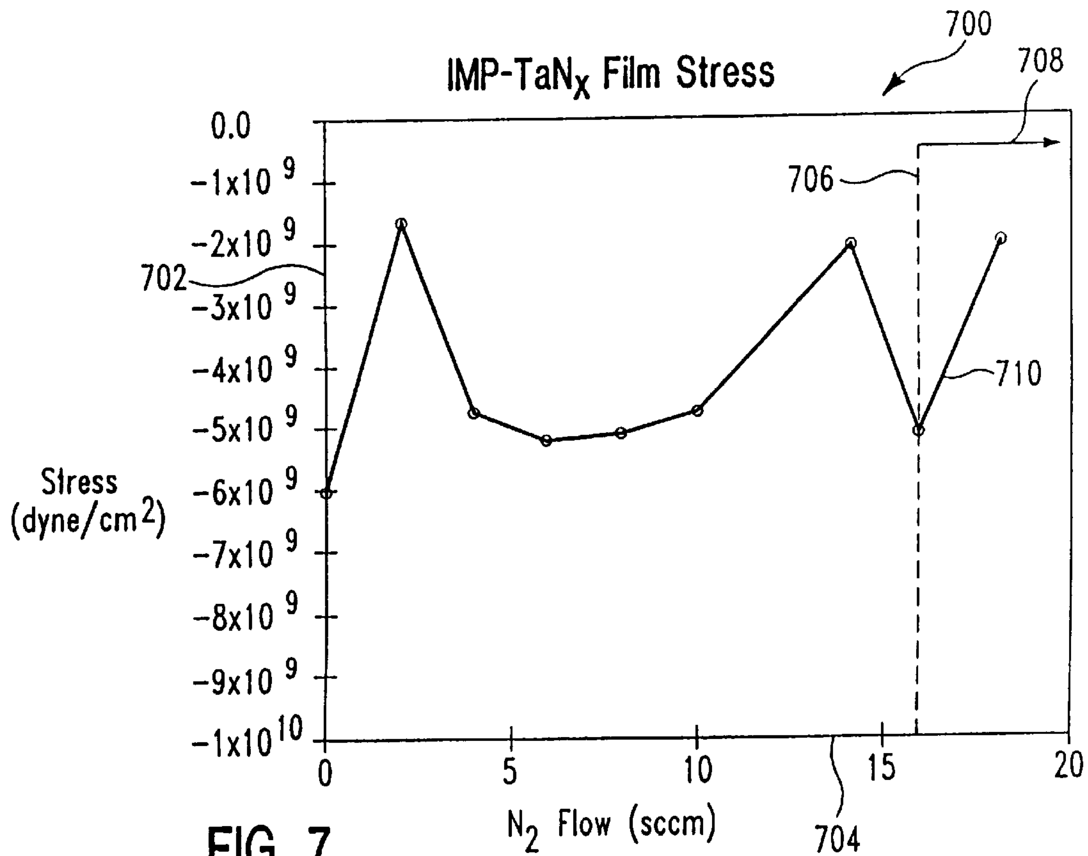

FIG. 7

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