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# United States Patent [19]

[11] Patent Number: **5,958,155**

**Kawamata et al.**

[45] Date of Patent: **Sep. 28, 1999**

[54] **PROCESS FOR PRODUCING THIN FILM**

Journal of Applied Physics, Oct. 1993., U.S.A., vol. 74, No. 8, "Radio frequency sputter depositon and properties of calcium fluoride thin films".

[75] Inventors: **Ken Kawamata; Nobuaki Mitamura,**  
both of Hachioji, Japan

Journal of Materials Science Letters, Aug. 1994, UK., vol. 13, No. 16, Temperature dependence of sputtering yield of GaAs under 30 keV ar/sup +bombardment..

[73] Assignee: **Olympus Optical Co., Ltd., Japan**

[21] Appl. No.: **08/683,195**

[22] Filed: **Jul. 18, 1996**

[30] **Foreign Application Priority Data**

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*Assistant Examiner*—Steven H. VerSteeg  
*Attorney, Agent, or Firm*—Ostrolenk, Faber, Gerb & Soffen, LLP

Jul. 20, 1995 [JP] Japan ..... 7-184454

[51] **Int. Cl.<sup>6</sup>** ..... **C22C 23/00**

[52] **U.S. Cl.** ..... **148/420; 420/402; 359/580;**  
204/192.12; 204/192.26; 204/192.29; 204/298.09

[58] **Field of Search** ..... 204/192.12, 192.26-192.29,  
204/298.09; 148/420; 420/402; 359/580

[57] **ABSTRACT**

A substrate (2) is rotatably installed in a vacuum chamber (1) at an upper part thereof MgF<sub>2</sub> granules (3) as a film source material are placed in a quartz boat (4) and mounted on a magnetron cathode (5). The magnetron cathode (5) is connected through a matching box (6) to a 13.56 MHz radio frequency power source (7). Cooling water (8) for holding the temperature of the magnetron cathode (5) constant flows against a lower face of the magnetron cathode (5). A side wall of the vacuum chamber (1) is provided with gas introduction ports (9), (10) for introducing gas in the vacuum chamber (1). A shutter (11) is placed between the magnetron cathode (5) and the substrate (2). This structure provides a process enabling forming a thin film at a high speed by sputtering, especially a high speed sputtering process enabling forming a thin fluoride film free of light absorption.

[56] **References Cited**

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Vacuum, Dec. 1985. UK., vol. 35, No. 12, "Thin films prepared by sputtering MgF/sub 2/ in an RF planar magnetron".

**11 Claims, 10 Drawing Sheets**

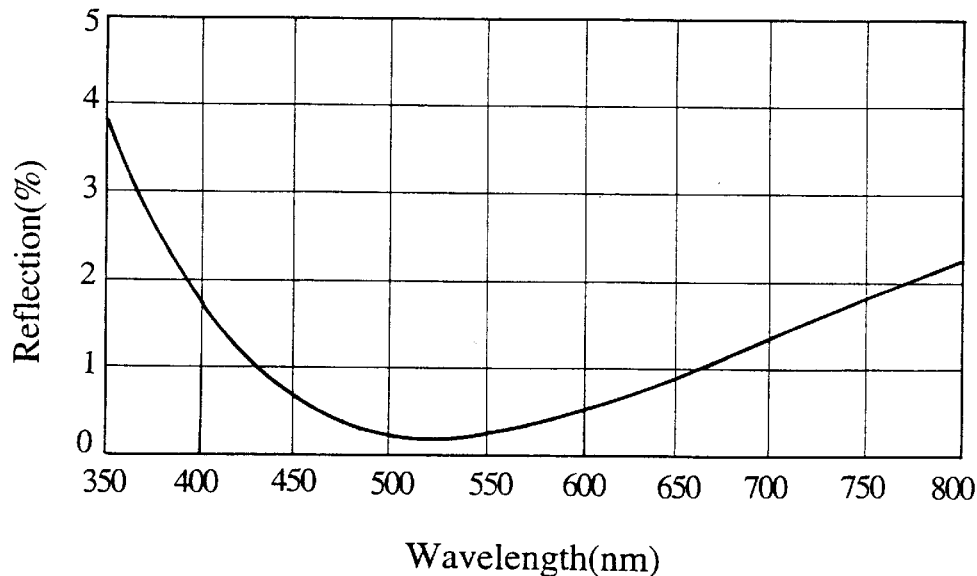


FIG. 1

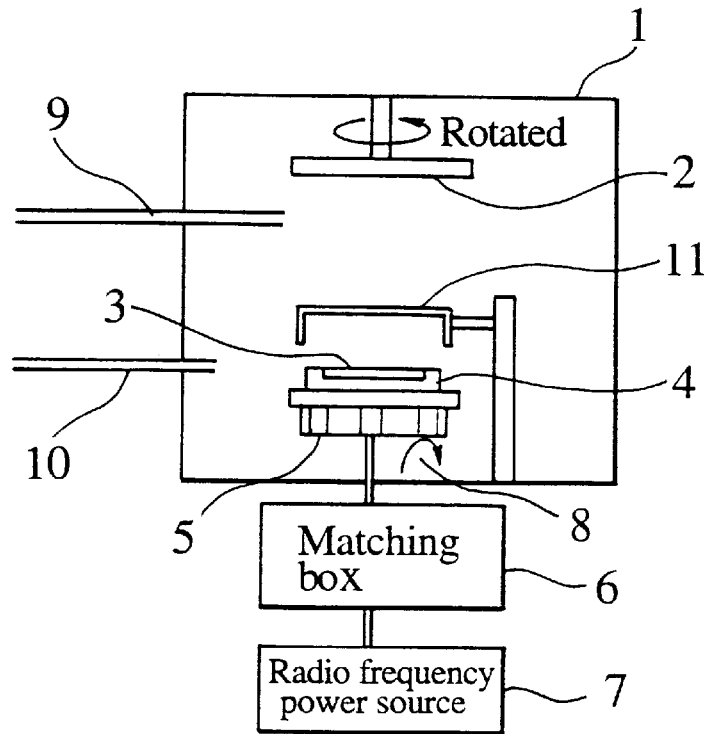


FIG. 3

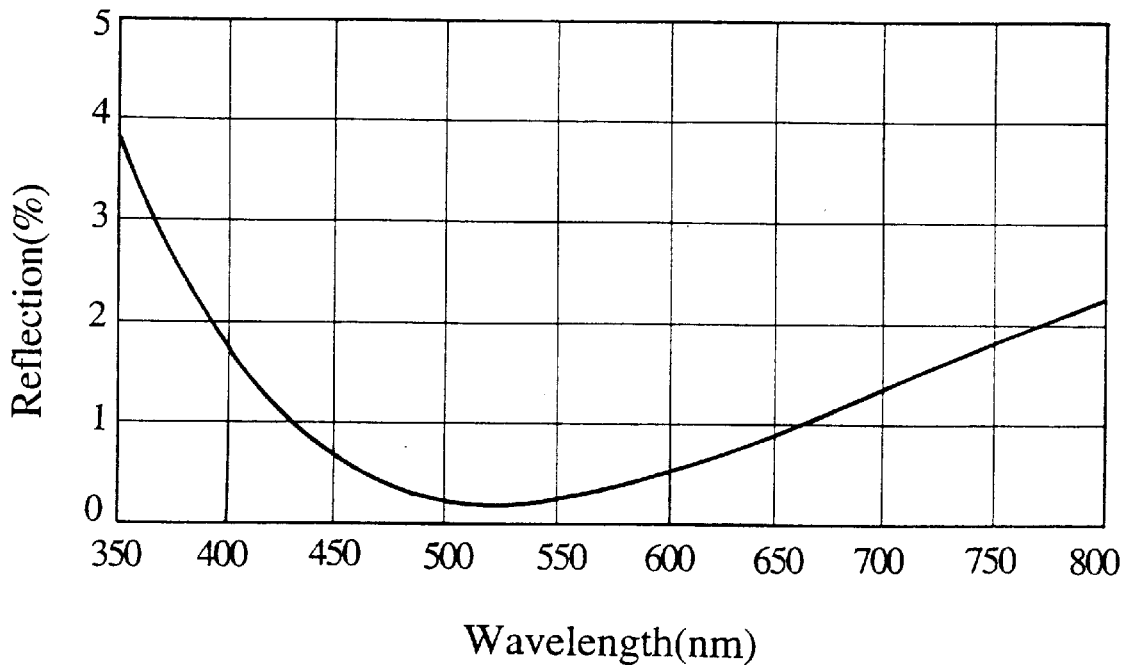
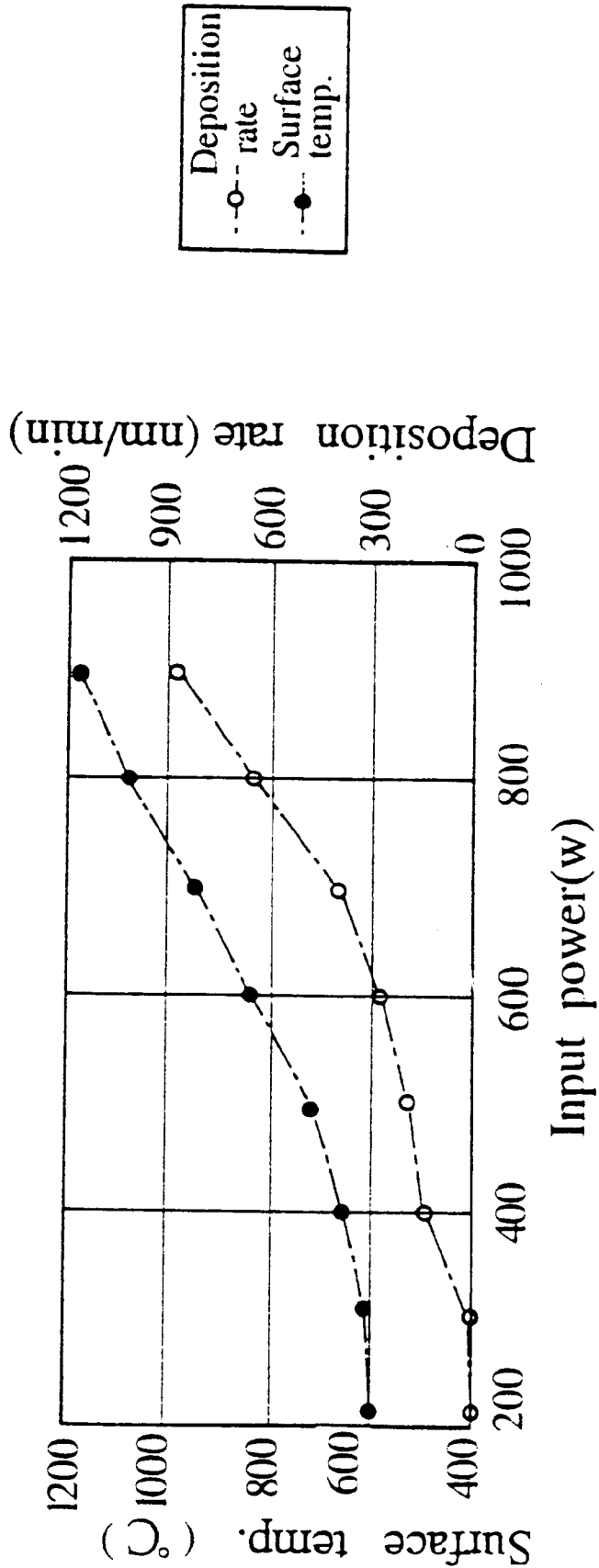


FIG. 2



Deposition rate  
Surface temp.

FIG. 4

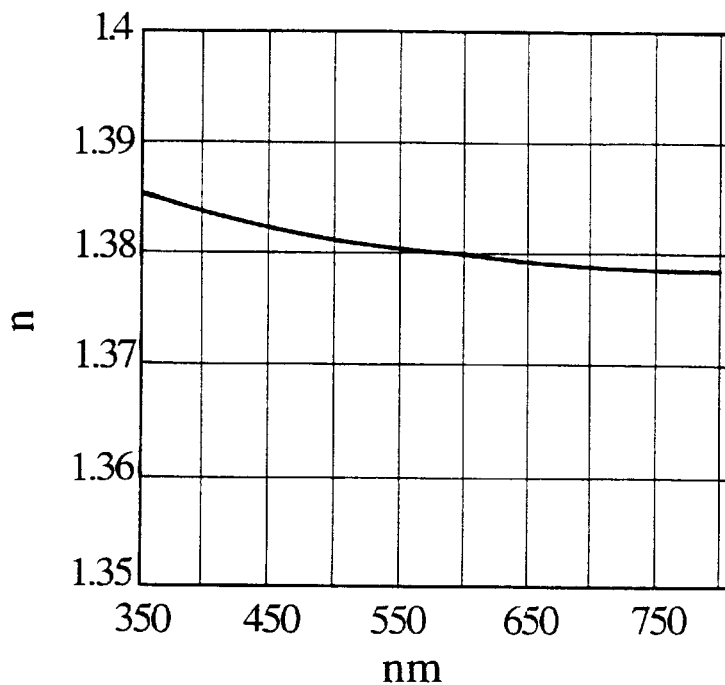


FIG. 5

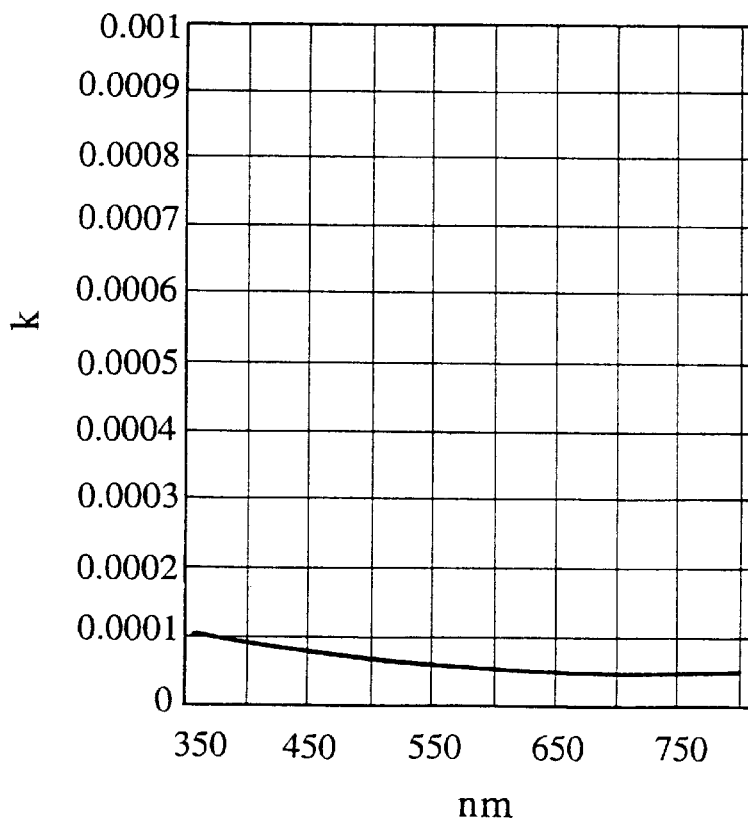
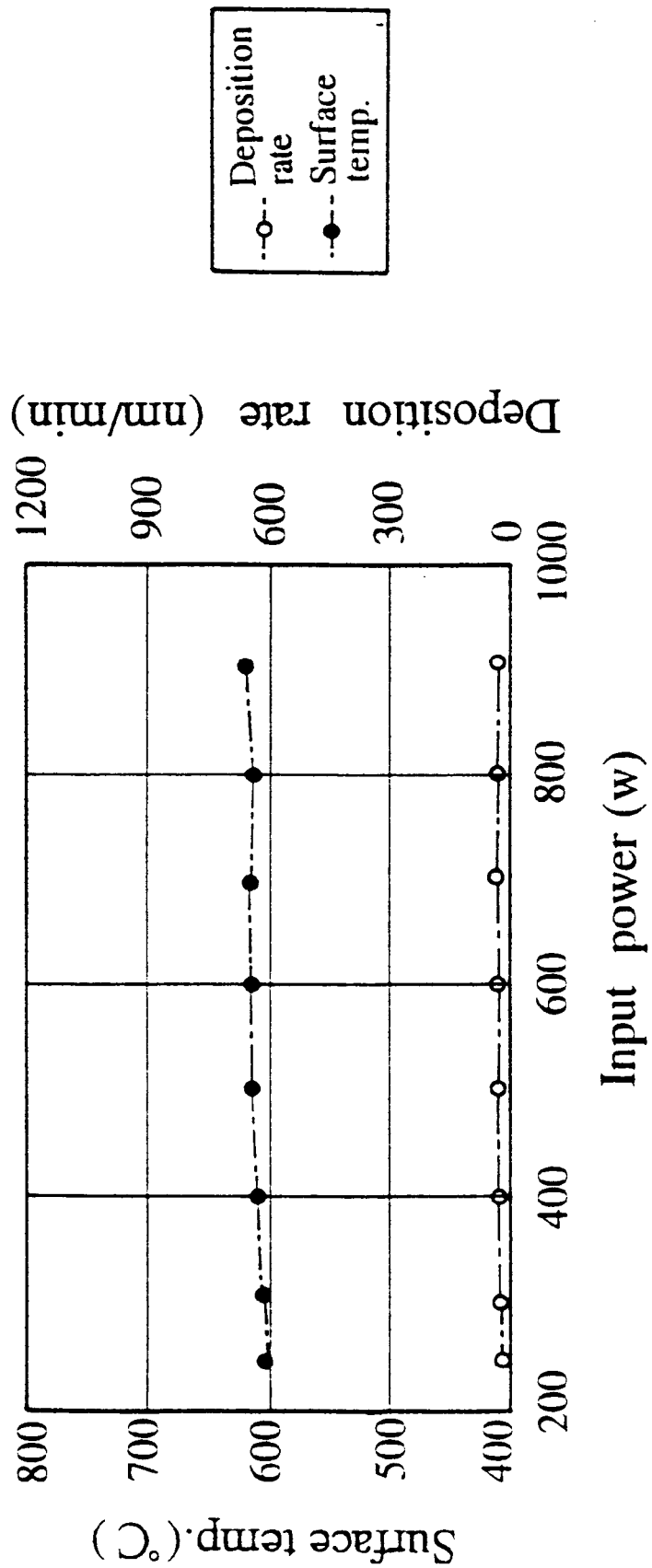


FIG. 6



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