一般セッション(口頭講演) | 8 プラズマエレクトロニクス：8.6 Plasma Electronics English Session

2024年9月18日(水) 18:45 ~ 19:00 A32 (朱鷺メッセ3F)

[18p-A32-20~20] 8.6 Plasma Electronics English Session

呉 準席(阪公大)

英語発表

18:45 ~ 19:00

[18p-A32-20]

Investigation of Metal-Organic Plasma Enhanced Chemical Vapor Deposition for Yttrium Oxide film using a Microwave Excited Atmospheric Pressure Plasma Jet

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Investigation of Metal-Organic Plasma Enhanced Chemical Vapor Deposition for Yttrium Oxide film using a Microwave Excited Atmospheric Pressure Plasma Jet

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Introduction: Yttrium Oxide (Y_2O_3) is an attractive insulator material that has higher corrosive resistance than conventional ceramics of alumina (Al_2O_3), silicon carbide (SiC), and silicon nitride (Si_3N_4). This makes Y_2O_3 a preferred choice for protective coatings against corrosive plasma in the etching chamber. Various methods have been developed for Y_2O_3 film, including thermal spray, sputtering, and atomic layer deposition. However, cost-related issues such as operation and maintenance of equipment, still remain. A microwave atmospheric pressure plasma jet (MW-APPJ) generates high-density reactive species at low-temperatures and operates without requiring costly vacuum equipment.

Therefore, in the present study, we deposited Y_2O_3 film through the MW-APPJ, employing a relative cost-effective yttrium acetate with an innovative organic additive solution in a metal-organic chemical vapor deposition (MOCVD) system.

2. Experimental: Figure 1 illustrates the MW-APPJ with a bubbling system. The MW-APPJ consisted of a cylindrical metal container that has a single gas inlet port. A rectangular waveform at 10 kHz was used to modulate the 2.45 GHz microwave amplitude as an input. The peak power was 230 W with an on-time duty factor of 30%. The average input power (P_{avg}) was 70 W. Argon used both working gas (Q_w) and carrier gas (Q_c). Organic Y_2O_3 precursor solution in a tank was introduced into to plasma reactor via a gas inlet port by a Q_c. A quartz glass substrate of 1 mm thick was placed on a stage. The substrates are heated up to 100°C (T_s) by a hot plate. The distance between substrate surface and the MW-APPJ nozzle was 5.5 mm. Duration of the deposition was 20 min. Conventional x-ray diffraction (XRD) and grazing incidence x-ray diffraction (GI-XRD) were used to examine the crystallinity of the deposited films.

3. Results and discussions: Figure 2 shows the XRD and GI-XRD spectra of the Y_2O_3 films deposited on quartz substrates under different carrier gas flow rates. There were no obvious peaks appearing in the XRD spectra of all samples in Fig. 2 (a). However, in the GI-XRD spectra, the Y_2O_3 films fabricated under carrier gas flow rate of 139 sccm showed dominant peaks corresponding to a (332) reflection at around 45.3°. as shown in Fig. 2 (b). Additionally, there is a presence of (444) Y_2O_3 reflection at around 66.9°.

Interestingly, the difference from previous studies [1,2] that reported Y_2O_3 films prepared by MOCVD were normally amorphous when growth temperature was lower than 400°C. To further enhance the film quality of deposited Y_2O_3 film, several experimental parameters such as gas flow rates, microwave power, and substrate temperatures are investigated systematically.

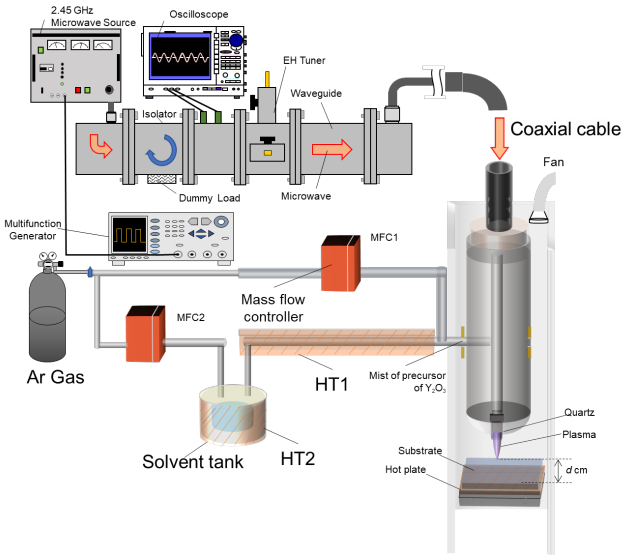

Figure 1. MW-APPJ with a bubbling system.

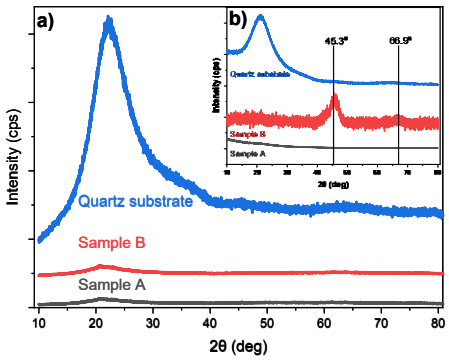

Figure 2. (a) XRD and (b) GI-XRD diffraction pattern of deposited Y_2O_3 films different carrier gas (Q_c) flow rate: sample A (grey) 70 sccm, sample b (red) 139 sccm, and blank quartz substrate (blue).

References:

[1] S. Karle, *et al.*, Chem. Vap. Deposition **335** (2015) 21.
[2] D. Niu, *et al.*, J. Electrochem. Soc. **F102** (2003) 150.