

## [IV-8]

### PREPARATION OF CERAMIC THIN FILMS BY PLASMA-ENHANCED MOCVD

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#### Introduction

For preparation of oxides films, CVD method offers many advantages: i.e., excellent film uniformity, easy component control and a high deposition rate.

In this study, plasma-enhanced MOCVD technique was utilized for the preparation of ceramic thin films.

#### Experimental

The plasma-enhanced MOCVD apparatus used in this study has six vaporizers and a reactor with parallel plate electrodes. Some magnets were placed in a coaxial circle below the bottom electrode

The metalorganic compounds  $Mg(C_5H_7O_2)_2$ ,  $Ni(C_5H_7O_2)_2 \cdot 2H_2O$ ,  $Co(C_5H_7O_2)_2 \cdot 2H_2O$ ,  $Fe(C_5H_7O_2)_3$ ,  $Pb(C_{10}H_{14}O_2)_2$  and  $Ti(i-OC_3H_7)_2$  were used as Mg, Ni, Co, Fe, Pb and Ti sources, respectively. The ceramic thin films were obtained as follows. Each vapor of these sources was introduced into the reactor through a gas line with  $N_2$  carrier gas and  $O_2$  reactant gas under reduced pressure. Then, rf (13.56 MHz) power was applied across the parallel plate electrodes and the deposition was carried out on preheated substrates. The substrates used were soda-lime glass, Si(111), stainless steel and fused silica.

#### Results and Discussion

##### (a) NaCl-Type Oxide Films

The ceramic films of NaCl-type oxides such as MgO, NiO and CoO were deposited on soda-lime glass substrates at rf power of 400W and substrate temp. of 150-400°C by using each vapor of Mg, Ni and Co sources as CVD gas, respectively (depo. rate: 20-50 nm/min). These films possessed a high orientation of (100), independent of the substrate temperature. Fused silica, Si(111) and stainless steel were used as the substrates instead of soda-lime glass. All MgO, NiO and CoO films deposited possessed high (100) orientation, independent of the kind of substrate (Fig. 1).

##### (b) Spinel-Type Iron Oxide Films

The films of spinel-type iron oxide  $Fe_3O_4$  were obtained on

soda-lime glass substrates at rf power of 400W and substrate temp. of 300-400 °C by using Fe source vapor as CVD gas (depo. rate:50 nm/min). They have good crystallinity with preferential (100) orientation, forming columnar structure. When Si(100) or fused silica were used as substrate instead of soda-lime glass, preferentially (100) oriented  $Fe_3O_4$  films were obtained, independent of the kind of substrate.

### c) Perovskite-Type Lead Titanate Films

The film of high crystalline  $PbTiO_3$  with perovskite structure was obtained on a soda-lime glass substrate at rf power of 200W and substrate temp. of 570 °C by using mixed vapor of Pb and Ti sources as CVD gas (depo. rate:180 nm/min) and the film possessed a high orientation of (100), i.e., tetragonal a-axis (Fig. 2).

### Conclusion

It was found that plasma-enhanced MOCVD for the ceramic thin films had some advantages, such as a high deposition rate and low temperature formation on ceramic films with good crystallinity.

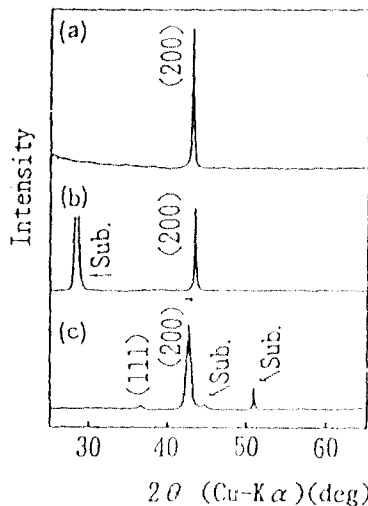


Fig.1. XRD patterns of (a) MgO film on fused silica, (b) NiO film on Si(111) and (c) CoO film on stainless steel at 400°C.

### References

1. E.Fujii, A.Tomozawa, S.Fujii, H.Torii, M.Hattori and R.Takayama: Jpn. J. Appl. Phys., 32(1993), L1448.
2. H.Torii, E.Fujii and M.Hattori: Proc. 6th Int. Conf. Ferrite, Kyoto, 1992, p.464.
3. E.Fujii, A.Tomozawa, S.Fujii, H.Torii and R.Takayama; Appl. Phys Lett., to be published.

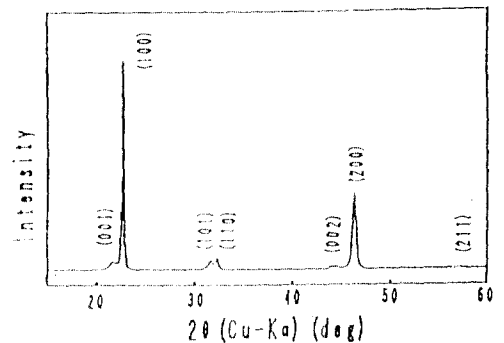


Fig.2. XRD pattern of  $PbTiO_3$  film on soda-lime glass at 570°C.