Interface chemical reaction in MBE growth of MgF_2 on Si: Towards a new growth technique for epitaxial $MgSiN_2$

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Introduction

We are exploring a method for growth of epitaxial $MgSiN_2$ thin film. $MgSiN_2$ is expected as a material for ultraviolet light emitting devices and as a buffer layer application for heteroepitaxy on dissimilar substrates. However, in the case of epitaxial growth process such as molecular beam epitaxy (MBE), if Mg and Si are supplied independently combining nitridation, it is concerned that non-uniform clustering is likely to occur due to the difference in binding energy with N so that uniform epitaxial growth is difficult. Therefore, we consider the use of a uniform solid-phase reaction of Si and Mg combined with its nitridation.

As a first step, in this work, the solid-phase reaction of Si and Mg under the MBE process is investigated. A possibility of such reaction was indicated in the MBE growth of MgF_2 on Si(111) substrates [1]. The experiments were performed based on the knowledge.

Experiments

MgF_2 was epitaxially grown on Si substrates at various growth temperatures using MgF_2 molecular beam from a solid source of MgF_2. Thickness of grown films were from 60 nm to 90 nm. Growth rate was 3nm/min. In depth profiles of chemical composition and chemical shifts were observed by X-ray photoelectron spectroscopy (XPS).

Results

Figure 1 shows obtained Mg2p spectra for the samples grown at 350ºC and 600ºC. At each depth near interface (sputtering time of 30.0 min for the 350ºC sample, and that of 46.5 min for the 600ºC sample), sub peaks having binding energy (BE) different from that of MgF_2 are detected. A possible origin is MgO_x since small O1s peak is detected localized at the interface (not shown here). The other possible origins are metallic Mg and Mg_xSi. Since BE of them are close each other, clear determination is difficult as far as the results. However, it is expected that decomposition of MgF_2 by solid phase reaction with Si was occurred. In order to clarify such chemical reaction, experiments of growth at more higher temperatures and post heating process in which samples are heated up to higher temperature *in situ* after the growth at medium temperatures are under planning, and their results will be presented.

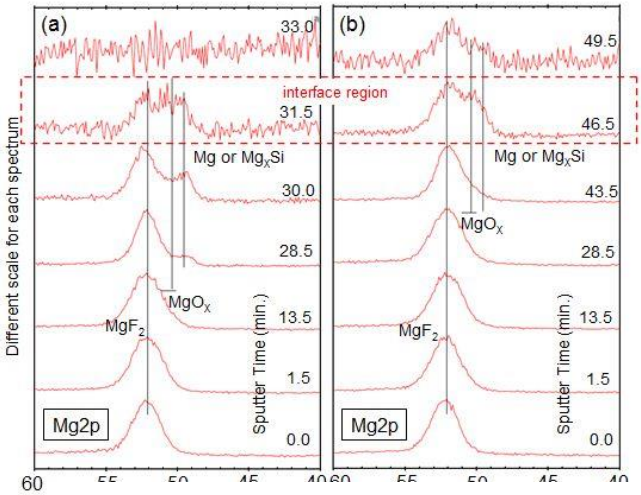

Fig.1 In depth profiles of Mg2p spectra for samples grown at (a) 350ºC and (b) 600ºC.

Reference

[1] 神林　ほか, 秋季応物学会, 19p-E310-18, 2019.