observed for the Si2p spectra as increasing process temperatures from "as depo" to 600 C°, indicating that Si-N bonds in the heated polysilazane surface were dissociated and recombined with oxygen atoms to form Si-O bonds. In consistent with the Si2p shifts, intensities of the N1s or O1s spectra were decreased or increased with process temperatures, respectively. The surface of the thermally fabricated coatings at 600 C° were completely converted to SiO_2 without any residual nitrogen atoms.

As shown in the fig. 1(g), the surfaces of photochemically fabricated coatings are found to be equivalent to that of the thermally fabricated coatings at 600 C°, because no residual nitrogen atom was detected for these coatings.

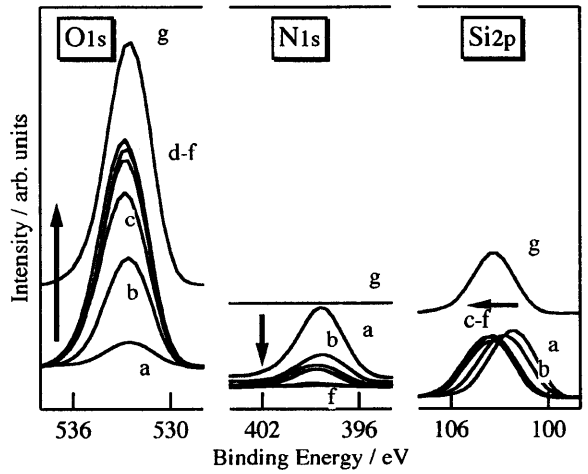

Fig. 1. X-ray photoelectron spectra of thermally (a-f) or photochemically (g) fabricated coatings : (a) as depo, (b) 200 C°, (c) 300 C°, (d) 400 C°, (e) 500 C°, (f) 600 C°, (g) VUV irradiated.

3.2 IR absorption spectra

Figure 2 shows IR absorption spectra of thermally (a-f) or photochemically (g) fabricated coatings from polysilazane, respectively. IR absorption spectroscopy gives average chemical information across the film depth. So complementary information can be extractable from the XPS and IR spectra of the coatings. As shown in the fig. 2(a-f), N-H stretching bands at 3370 cm^{-1}, Si-H stretching bands at 2160 cm^{-1}, and Si-N bands at 830 cm^{-1} were decreased as increasing processing temperatures. Whereas Si-O bands at 1060 and 450 cm^{-1} were increased. These spectral changes are reasonably explainable with the structural change from $(-SiH_2-NH-)_n$ (polysilazane) to SiO_2 (silica glass) occurring all over the film.

As shown in the fig. 2(g), it was found that the average chemical structure of photochemically fabricated coatings across the depth is nearly equal to the thermally fabricated coatings between 200 ~ 300 C°.

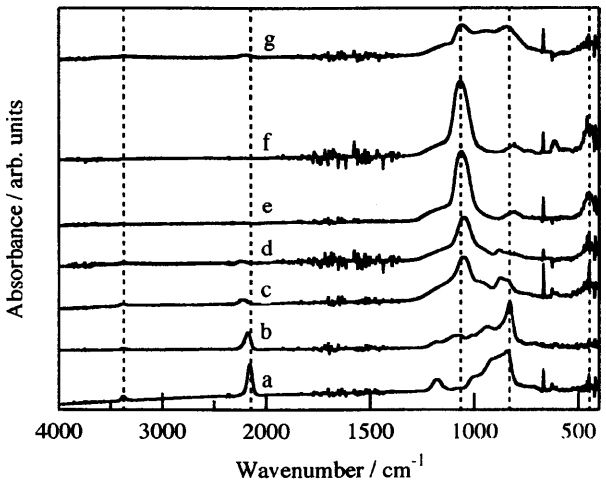

Fig. 2. IR absorption spectra of thermally (a-f) or photochemically (g) fabricated coatings : (a) as depo, (b) 200 C°, (c) 300 C°, (d) 400 C°, (e) 500 C°, (f) 600 C°, (g) VUV irradiated.

3.3 Discussion

From the XPS and IR spectroscopic investigations of photochemically fabricated silica glass coatings at room temperatures, there found a difference in quality between the surface and the bulk state of the coatings. For the photochemical conversion process from polysilazane to SiO_2, it needs any kind of oxygen supply from gas phase such as O_2 molecule in dry air, O_3 or O radicals produced by VUV photolysis of O_2, because polysilazane itself does not include oxygen atoms in its molecular structure. Thus that difference is explainable to the oxygen gas barrier characteristics of the photogenerated silica glass layer at the top of the silica glass coating.

4. Conclusion

In this study, the 172 nm VUV photoirradiation from recently developed high power xenon excimer lamps is found to be useful to achieve room temperature photochemical fabrication of quartz glass coatings from polysilazane.

References

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