

論文 / 著書情報
Article / Book Information

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Title(English)	
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種別(和文)	論文要旨
Type(English)	Summary

(博士課程)
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論文要旨

THESIS SUMMARY

専攻 : Department of	機械制御システム	専攻	申請学位 (専攻分野) : Academic Degree Requested	博士 (工学) Doctor of
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要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words)

This paper is composed of a series of research results on surface modification of synthetic resin using vacuum ultraviolet (VUV) light.

Chapter 1 is an introduction including general information on VUV light, plastics and silicones which are targets to surface modification by VUV light. In addition, this chapter also covers applications of these materials and their technological issues including plastic microfluidic devices, optical elements in VUV region and anti-reflection coating and possibilities of applying surface modification by VUV to these technological problems are also discussed.

Chapter 2 describes a novel bonding method for various kinds of polymers such as polycarbonate, cyclic olefin polymer, polydimethylsiloxane (PDMS) and poly(methyl methacrylate), and glass at atmospheric condition just by irradiating VUV light, which wavelength is less than 160 nm. The surface hydrophilicity, aging performance of hydrophilicity, bonding strength, chemical and physical changes are evaluated by several surface analyzing techniques. In addition, availability of this method to fabricate a microfluidic device is demonstrated. As a result, some combinations of plastics, silicone, and glass are successfully bonded. The surface analysis revealed that OH and CN group plays an important role for bonding, which is not primarily affected by surface roughness. In addition, microfluidic device by this method is successfully demonstrated and no leakage is confirmed to be occurred. From these result, the bonding method presented here will be applied to fabricate various plastic made microfluidic devices.

Chapter 3 describes a fabrication method of silica like layer by irradiating VUV light which wavelength is 172 nm to silicone rubber as an use of a low-cost optical material in VUV region. As a result of TOF-SIMS analysis of the bulk sample which VUV is irradiated in atmospheric and vacuum condition, the vitrification is deeply occurred in atmospheric condition due to reaction with reactive oxygen species generated by VUV irradiation. In the case of thin film sample on reflective layer, the vitrification is more improved than the bulk case due to the interaction between the incident and the reflective wave, which refractive index come close to silicon dioxide's. Finally, based on these results, optical coating of the vitrified silicone rubber layer on a sapphire substrate is tried. As a result, at most 9.6 % transmittance of the substrate was increased in VUV region. From these results, the vitrified silicone rubber can be used for an optical material in VUV region.

Chapter 4 describes a new low-cost fabrication method using direct bonding method between silicone and glass by VUV irradiation for inversed moth-eye structure which has been paid attention as anti-reflection structure. Simultaneously with the study of this manufacturing method, we develop UV-curable silicone rubber (UV-PDMS) which is expected to suppressing heat shrinkage during curing of thermosetting silicone rubber. As a result, UV-PDMS exhibits extremely low thermal shrinkage compared with thermoset type by 2 orders of magnitude was obtained, which indicates UV-PDMS is suitable for fabricating fine submicron scale structure like this research. In addition, bonding condition between UV-PDMS and glass by VUV irradiation is confirmed. Finally, based on these results, fabricating inversed moth-eye structure made of UV-PDMS on glass substrate is demonstrated. As a result of optical measurement, the transmittance of the glass is improved by about 3% at visible light region it gets good agreement with the designed value. From these results, the proposing method can be used for fabricating anti-reflection structure.

Chapter 5 is the conclusion which summarizes the results obtained in this paper.

備考 : 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

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