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（博士課程）
Doctoral Program

論 文 要 約

THESIS OUTLINE

系・コース： Department of, Graduate major in	材料 系 材料 コース	申請学位（専攻分野）： Academic Degree Requested	博士 （ 学術 ） Doctor of
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論文題目 Thesis Title	**In situ assembling of glass microspheres for 3D optical micro device by UV-NIR dual-beam optical tweezer system**

要約

Chapter 1: Introduction

In this chapter, the demand of interlayer router techniques for 3D multilayered photonic networks and the potentials of glass micro resonators are introduced. Advantages and disadvantages of micro assembling methods are shown to emphasize the importance of developing a novel assembling system and technique to conveniently fabricate 3D micro devices such as interlayer router for 3D networks.

Chapter 2: Development of the UV-NIR dual beam optical tweezers system

In this chapter, a novel UV-NIR dual beam optical tweezers system was developed for assembling of microspheres. The system performance including optical field and force distribution were numerically analyzed and practically measured. The ability to flexibly manipulate microspheres in liquid environment in free space was operated and managed.

Chapter 3: UV immobilization of silica microspheres on silica substrates

In this chapter, a customized UV immobilization method based on photopolymerization of 3-methacryloxypropyltrimethoxysilane (MOPS) was developed to immobilize the target microsphere in the desired position. The protocol was optimized by quantitively evaluating the UV immobilization parameters, including UV exposure time, reagent concentration of MOPS and photoinitiator, and reacting time for coating the monolayer. Optical force spectroscopy was performed using the optical tweezers to directly measure the bonding strength of MOPS chains at different MOPS concentrations.

Chapter 4: Assembling of triangular pedestal structure for 3D optical router

In this chapter, effective combination of two steps in former chapters was developed,

consisting of manipulation and immobilization *in situ*. Assembly of arbitrary structures and accuracy were evaluated to confirm the ability of this UV–NIR dual-beam optical tweezer system as a micromanufacturing tool for the precise construction of functional structures. A flexible triangular pedestal structure was designed and assembled for the application of interlayer routers in multilayered 3D photonics networks.

Chapter 5: Fabrication of tellurite thin film waveguides on silicate substrates

In this chapter, the fabrication of tellurite thin film by the glass blowing technique was developed and served as the planar waveguide of the interlayer router under the pedestal. Surface -OH density of tellurite glass was increased by UV O3 treatment, and the water contact angle was measured to evaluate the performance. The ATR-FTIR spectra was measured, which indicated the successful coating of the MOPS monolayer on the tellurite thin film, which was necessary for pedestal immobilization.

Chapter 6: Assembling of 3D optical router with tellurite micro resonator

In this chapter, the assembling of triangular pedestal structures on MOPS coated tellurite films and the fabrication of Nd^{3+} tellurite micro resonators were developed to make a complete router device. The MOPS coated tellurite thin film was bonded on the silicate cover glass, and the pedestal was assembled on it INVERTEDLY. The Nd^{3+} doped tellurite glass micro resonators were fabricated by the local laser heating technique and placed on the pedestal to realize a 3D optical router by the micro vacuum manipulator.

Chapter 7: Optimal structure morphology of 3D optical router

Optimal structure morphology of 3D optical router was discussed for high performance. Coupled signal in waveguides was measured and coupling performance was evaluated. Obvious directivity along horizontal orientation was observed. Whispering gallery modes were successfully raised and coupled into waveguides from resonator, indicating the ability of interlayer coupling as an optical router for 3D networks.

Chapter 8: Conclusion

General conclusion was demonstrated of this doctoral thesis. The prospect of this 3D assembling technique and the future works were discussed to show its great potential as a noninvasive and accurate tool for various micromanufacturing and 3D photonic network applications in optical communication.