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Fabrication of ultrathin tellurite glass film on a substrate by using a combination of glass blowing and direct bonding techniques

ガラスブローイング法によるテルライトガラス超薄膜の作製と光学基板への直接接合

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➢ Outline of the thesis

In order to decrease the size of 3D optical integrated circuits, the waveguide fabrication process was separated into film fabrication and coating processes. The film fabrication process was depended on the glass blowing technique; the direct bonding technique was used for the coating process. Tellurite glass thin film, which is suitable for single mode waveguide, was fabricated by glass blowing technique using 27 mL introducing air into tellurite balloon at 550 ˚C, and the o.35 μm thick in an area of 16 × 5 cm^2 film was obtained. Tellurite glass was able to adhere to silicate glass under 15 and 62% relative humidity (RH) at room temperature. The water and OH groups on the silicate glass surface affected the adhesion strength, but tellurite glass had little water and OH groups on its surface. The very strong hydrogen bond would form when adhesion occurred at 15% RH.

Tellurite glass can adhere to crystal or amorphous materials, and it tends to make strong bonding with hydrophilic surface. After adhesion and peeling off, some of the components, including tellurium and niobium ions, of the tellurite film were found on the substrate silicate glass surface due to that Si–O–Te or Si–O –Nb might be formed. The sodium and calcium ions move from the silicate glass to tellurite glass during adhesion or peeling off by diffusion. In order to obtain stronger bonding strength, the

OH groups on the surface should be reduced.

Glass blowing technique can fabricate ultrathin glass film and it provides a simple process to fabricate glass thin film successfully. Direct bonding technique is a good method to bond glasses without post heating because no need is required to fit the thermal expansion coefficient of two materials. The ultra-smooth surface for processing direct bonding can be easily produced when tellurite glass is used. This research shows the factors for fabricating homogeneous ultrathin film for 3D optical integrated circuits.