（様式 5）

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学位（博士）論文要旨

(Doctoral thesis abstract)

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論 文 題 目 (Title)	面外駆動型Au ナノグレーティングによる複屈折可変メタサーフェス Birefringent reconfigurable metasurfaces based on Au nano-grating with out-of-plane actuation

論文要旨（2000 字程度）
(Abstract(400 words))
※欧文・和文どちらでもよい。但し、和文の場合は英訳を付すこと。
(in English or in Japanese)

In this thesis, birefringent reconfigurable metasurfaces (BRM) at visible wavelengths was obtained by combining an Au nano-grating metasurface, which shows very high birefringence characteristics in visible light, and a microelectromechanical system actuator.

The structural birefringence of the Au nano-grating can be controlled by dimensional parameters such as the thickness of the Au nano-grating. In this study, the birefringence modulation was demonstrated by controlling the effective thickness of Au nano-grating.

Two methods were devised to control the effective thickness by electrothermal driving method and electrostatic driving method by applying "out-of-plane deformation", which is an effective approach to obtain large amount of modulation. As theoretical analysis was performed, it was demonstrated that the modulation of birefringence retardation close to 180° can be obtained, at wavelengths of 0.46 μm, 0.53 μm, and 0.63 μm.

First, the out-of-plane motion BRM using electrostatic driving method was designed and fabricated. By the device, the modulation of retardation was achieved at a wavelength of 0.633 μm by up to 25.3°(from 21.5° to 46.8°) by applying a voltage in the range of 0-200 V. In addition, the relationship between retardation and deformation was investigated as a function of the initial deformation in an upward convex shape at the time at which the nano-grating structure was

released.

As the next approach, out-of-plane motion BRM using electrothermal driving method was designed and fabricated. The four fabrication processes were devised and demonstrated, and then the process which does not cause breakage of the structure or buckling after releasing was established. By the device, the modulation of retardation was achieved at a wavelength of 0.532 μm by up to 7.6° (from 86.2° to 78.6°) by applying a voltage in the range of 0-2.9 V.

In addition, the method was applied the finding that obtained by experimental verification of electrothermal driving method, to demonstrate a transmittance modulating birefringence metasurface (TRM). It was confirmed that the interference peak at a wavelength of 0.532 μm was red-shifted by 0.04 μm by applying a voltage.

In these studies, the knowledge of reconfigurable metasurfaces with birefringence characteristics has been obtained. Through experimental demonstration by multiple approaches, improvement points and next issues was clarified so that larger modulation characteristics will be obtained.

Au nano-grating has been studied, with possible applications such as micro-optical retarders including a half-wave plate, a quarter-wave plate, and a radial polarizer.

（英訳）※和文要旨の場合(400 words)