論文 / 著書情報
Article / Book Information

題目(和文)	表面ラベルグレーティング法を利用したフレキシブルフィルムの表面ひずみ解析
Title(English)	Surface Strain Analysis of Flexible Films by Means of Surface-Labeled Grating Method
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The purpose of this study is to quantitatively evaluate microscopic tension and compression in the surface of bending films by using the surface-labeled grating method, which measures the distance between a transmitted and first diffracted beams associated with bending of films.

In **Chapter 2**, the author prepared a CLCP film with a polysiloxane skeleton and the formation of surface-labeled grating. By a two-step method using synthesized monomers and crosslinking agent, a crosslinked azobenzene liquid-crystalline polymer film with a thickness of about 300 μm with uniaxial orientation was prepared. Reversible bending of the uniaxial-oriented film was induced by heat or light. In addition, a photomask was used to form a two-dimensional surface-labeled grating on the film surface, which was confirmed by polarized optical microscopy. These experiments showed that a periodic structure was formed only in the surface of the film.

In **Chapter 3**, the author explored the bending of films by mechanical stress or exposure to ultraviolet light by means of the surface-labeled grating method. A probe beam was incident to the film with the surface-labeled grating formed thereon, and generated diffracted beam was observed to locally and quantitatively evaluate the tension and compression in the film surface by bending. These experiments demonstrated that the compression and tension in the film surface layer associated with UV irradiation could be quantitatively evaluated in real time. Furthermore, the author was able to evaluate the difference in local deformation of films in detail. Deformation of the film by mechanical stress was a normal deformation mode in which the inner surface experienced compression while the outer surface experienced tension, in the same manner as in mechanics of hard materials. On the other hand, the bending of the film due to UV irradiation showed an unusual behavior of both surfaces experiencing

compression, indicating a new direction for mechanical analysis of soft matters, many of which problems have been unsolved yet.

In **Chapter 4**, the author designed a surface mechanical analysis system, and examined the analysis of surface strain associated with the bending of PDMS film made of flexible silicone elastomer. It was found that the deformation behavior of single-layer PDMS and bilayer PDMS films are vastly different. In addition, the author examined the analysis of the surface strain of flexible films used as flexible substrate such as a PEN film using a thin PDMS label. Using a silicon substrate with a periodic structure, the surface structure was transferred to a polymer film, and surface strain associated with the bending of the PEN film due to mechanical stress could be quantitatively evaluated.

In this research, the author designed a mechanical analysis system of flexible films that utilizes the surface-labeled grating method, and, for verifying the principle, developed a quantitative analysis method for photoinduced films and PDMS films. Using a PDMS film having superior flexibility as a label allows measuring surface strain in various flexible materials, and analyzing mechanical properties in detail. In addition, it might allow non-destructive examination of cracking, fatigue, etc., which cause problems during development processes of new flexible materials. Measurement of “strain”, which is a major factor in destruction and fatigue of materials, is essential in improving durability and flexibility of structures and products. In particular, in recent years, when development of wearable devices and flexible displays has been in progress daily, the author expects that the application of soft materials that are difficult to be analyzed with conventional method will expand widely.