論文 / 著書情報
Article / Book Information

題目(和文)	
Title(English)	Precise quantitative analysis of bending behavior in flexible polymer films
著者(和文)	田口諒
Author(English)	Ryo Taguchi
出典(和文)	学位:博士(工学), 学位授与機関:東京工業大学, 報告番号:甲第11979号, 授与年月日:2021年3月26日, 学位の種別:課程博士, 審査員:宍戸 厚,荒井 創,芹澤 武,大塚 英幸,中嶋 健,久保 祥一
Citation(English)	Degree:Doctor (Engineering), Conferring organization: Tokyo Institute of Technology, Report number:甲第11979号, Conferred date:2021/3/26, Degree Type:Course doctor, Examiner:,,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	要約
Type(English)	Outline

The purpose of this study is the development of new practical analysis method to evaluate bending behaviors of flexible polymer films. This would be key to developing mechanically durable materials and electronic devices. Herein, the author proposed an analytical method that simultaneously measures bending curvatures and surface bending strains in various polymer films, achieving the quantitative analyses of bending hysteresis, fracture limits, and bending fatigue.

In **Chapter 2**, the author demonstrated that the real-time measurement of bending curvature helps the understanding of bending behaviors in flexible polymer films. The mechanical analytical system that accurately and precisely measures curvatures was developed. Through measuring curvatures, bending hysteresis, arising from viscoelastic properties of polymer films, was successfully evaluated. It was revealed that the hysteresis was caused by the surface bending strain in a nonlinear region in terms of stress based on theoretical calculations.

In **Chapter 3**, the author demonstrated that the surface-labeled grating method is the powerful tool in measuring surface bending strains with multiple benefits: high resolution, precision, and a wide range of measurable materials, which is superior to the other available methods. The reliability of the measurements was confirmed using the modified Elastica theory. This method successfully determined the fracture limit that shows the surface bending strain at which cracking of hard coatings on the surface of PET films occurs. As a proof-of-concept, the author showed that the multi-layering of two PET layers with a soft PDMS layer between them reduced the surface bending strain by 50% compared with that of a single-layer film with the same thickness. This triple-layer film

successfully suppressed the cracking of the hard coating and the breakdown of the OTFT.

In **Chapter 4**, the author discussed the bending fatigue of polymer films through simultaneous measurements of curvatures and surface bending strains. By the bending analysis method proposed in this study, the author successfully evaluated the bending fatigue.

In this study, the author explored the accuracy, precision, resolution, and versatility of the surface-labeled grating method, and furthermore, demonstrated that the method helps developing flexible electronic devices and elucidating fracture phenomena. The surface strain is determined from the diffraction angle change of an incident laser beam, which is indicative of the change in the grating periodicity in the bending surface. Thus, this method merely requires forming an optical grating label on surfaces of any interests such as polymeric, inorganic, and hybrid films composed of single- and multi-layered structures. Therefore, the surface-labeled grating method is a practical tool that allows the real-time analysis of surface bending strain in various interests.