論文 / 著書情報
Article / Book Information

題目(和文)	高分子フィルムおよびマイクロ・ナノ材料の赤外領域における光学特性および熱放射特性
Title(English)	Optical Properties and Thermal Radiation of Polymer Films and Micro/Nano Materials in the Infrared Region
著者(和文)	HoangThi Thanh Tam
Author(English)	Tam ThiThanh Hoang
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

系・コース： Department of, Graduate major in	電気電子	系 コース	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of	Engineering
学生氏名： Student's Name	HOANG THI THANH TAM		指導教員（主）： Academic Supervisor(main)	Prof. Kotaro Kajikawa	
			指導教員（副）： Academic Supervisor(sub)		

要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Recently, the infrared (IR) region (λ = 2.5 to 25 μm) has been essential in science and technology fields for two reasons. (1) It is referred to as the fingerprint region, where the presence of these molecules can be detected via their unique spectral signatures; thus, it is essential for analyzing materials and sensing applications. (2) It covers the thermal radiation spectrum of most objects and the atmospheric transmittance window (ATW). Thus, the investigation of the IR region is vital to investigating modern cooling technologies such as radiative cooling (RC). Based on this knowledge, the objective of our study is to investigate the optical properties and the thermal radiation from polymer films and micro/nano materials in the IR region and examine RC technology.

This study investigated the optical properties of silica microspheres for RC application through the surface phonon polaritons resonance (SPhPR). The SPhPR was observed at 9 and 21 μm, consistent with the Mie theoretical results. Because of silica's intrinsic properties, gold-capped microspheres were applied with the expectation that gold could act as an antenna for exciting SPhPR in the longer wavelength. Although SPhPR was not excited as expected, the extraordinary transmittance (EOT) phenomenon was explored. The EOT is well known in the visible region, while the knowledge in the IR region has not been reported yet. The observed transmittance is greater than that of the flat gold film; even the surface of the gold-capped microsphere appears as wholly covered with the gold film. The finite-difference time-domain (FDTD) calculation indicates that light passes through the openings between the gold film on the substrate surface and the gold cap. The EOT occurs in the broadband, free from resonance, and is absent in the visible and near IR region, where gold does not function as an ideal metal.

Next, we explored the thermal radiation property through the RC characterization of polymer materials. The RC technology can cool things with no electricity; thus, it has been applied to various fields, such as clothing, energy harvesting, and solar cells. Furthermore, the outstanding property of polymers is able to use in flexible forms such as films or paint; thus, they promise real applications with low fabrication costs. This study demonstrated that polyester polymers and fluoropolymer are good candidates for daytime RC materials. They are transparent in the visible region while emitting in the ATW; thus, they can provide high RC performance. In addition, our reported materials have paint-ability and weather-ability; therefore, they can apply in the larger area with long-term use. Finally, the RC efficiency of samples was compared with some reported materials such as polydimethylsiloxane (PDMS), soda-lime glass (glass), and silica particles on the glass.

On the other hand, we realized RC materials also adversely affect daily life, such as frost on the car windshield or condensation on the window. To our knowledge, no non-RC materials have been reported yet. Thus, we found some transparent non-RC materials such as indium tin oxide (ITO), dielectric-metal-dielectric (DMD), and silver nano-mesh (AgNWs) materials to block unwilling thermal radiation. While the non-RC performance of ITO and DMD films is better than that of the AgNWs film, they pose challenges such as the high fabrication cost and enlargement difficulties. The AgNWs film promises for coating in the larger area because of the paintable property. Thus, we can choose suitable materials for the targeted application.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

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