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Oblique-angle sputtering에 의한 Indium tin oxide 이중층 반사방지막 특성에 관한 연구

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높은 굴절률(n_H) 의 ITO films 위에 homoepitaxial 성장 기술로 낮은 굴절률(n_L) 의 ITO를 이중으로 증착한 반사방지막을 연구하였다. 우리는 기판 상에 vapor flux 입사 각도 및 columnar 성장막과 경사각 사이의 상관 관계에 기초하여 낮은 굴절률의 ITO 박막을 Oblique-angle sputtering을 사용하여 증착하였다. Oblique-angle 증착동안 columns 경사각이 incident flux angle 의 증가에 따라 linear 하게 증가했다. 반대로 incident flux angle 이 증가할때 ITO 박막의 굴절률은 현저하게 감소하였는데, 이는 원자의 shadowing effect와 표면 diffusion으로 인하여 필름내의 porosity를 증가시킨 것으로 보여진다. 이러한 결과로 homoepitaxial으로 성장시킨 ITO 이중층 구조 반사방지막 특성이 향상되었으며, 유리 기판 위에서 weight average reflectance가 n_L=1.72, n_H=1.90 에서 6.57%를 달성하였다.

Keywords: Oblique-angle sputtering, Homoepitaxial, ITO 박막, 굴절률

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CNT-PDMS Composite Thin-Film Transmitters for Highly Efficient Photoacoustic Energy Conversion

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Photoacoustic generation of ultrasound is an effective approach for development of high-frequency and high-amplitude ultrasound transmitters. This requires an efficient energy converter from optical input to acoustic output. For such photoacoustic conversion, various light-absorbing materials have been used such as metallic coating, dye-doped polymer composite, and nanostructure composite. These transmitters absorb laser pulses with 5-10 ns widths for generation of tens-of-MHz frequency ultrasound. The short optical pulse leads to rapid heating of the irradiated region and therefore fast thermal expansion before significant heat diffusion occurs to the surrounding. In this purpose, nanocomposite thin films containing gold nanoparticles, carbon nanotubes (CNTs), or carbon nanofibers have been recently proposed for high optical absorption, efficient thermoacosutic transfer, and mechanical robustness. These properties are necessary to produce a high-amplitude ultrasonic output under a low-energy optical input. Here, we investigate carbon nanotube (CNT)-polydimethylsiloxane (PDMS) composite transmitters and their nanostructure-originated characteristics enabling extraordinary energy conversion. We explain a thermoelastic energy conversion mechanism within the nanocomposite and examine nanostructures by using a scanning electron microscopy. Then, we measure laser-induced damage threshold of the transmitters against pulsed laser ablation. Particularly, laser-induced damage threshold has been largely overlooked so far in the development of photoacoustic transmitters. Higher damage threshold means that transmitters can withstand optical irradiation with higher laser energy and produce higher pressure output proportional to such optical input. We discuss an optimal design of CNT-PDMS composite transmitter for high-amplitude pressure generation (e.g. focused ultrasound transmitter) useful for therapeutic applications. It is fabricated using a focal structure (spherically concave substrate) that is coated with a CNT-PDMS composite layer. We also introduce some application examples of the high-amplitude focused transmitter based on the CNT-PDMS composite film.

Keywords: Photoacoustic energy conversion, carbon nanotube polymer composite, ultrasound transmitter