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프 로 그 램

일시: 2014년 8월 25일(월) ~ 27일(수)
장소: 제주 국제 컨벤션 센터
주최: 한국광학학회
후원: 한국과학기술단체총연합회
17:45 T3C-Ⅲ 3 분광계적 시스템과 분광표현에 관한 연구

From bio-mimetic structures inspired by Morpho butterfly wings, we have investigated the effect of nanoscale disorder among the multilayered ridges on broad-angle reflection.

18:00 T3C-Ⅳ 4 반사형 코로나프로필을 이용한 물체 앞 점개 정한성 분석에 관한 연구

본 연구는 반사형 코로나프로필 홀로그램을 구현하여 물체에 대한 점개 정한성이를 interfernce fringes로부터 직접 추출하였으며, 물체의 점개 정한성에 대한 정확성을 본론하였다.

18:15 T3C-Ⅴ 5 도플러 OCT를 이용한 생체 내 이동의 전동 검출

Doppler Optical Coherence Tomography can offer 2-dimensional in real time tomogram of rapidly oscillatory mouse tympanic membrane and ossicular chain in vivo.

미지일률프로파그리 및 정보광학Ⅲ: 3D Display Ⅱ (T3D-Ⅱ)
17:00-18:30 / 202B 사장: 최재현(세종대)

17:00(초청논문) T3D-Ⅱ 1 3D 영상 표준저자의 평가

3D 영상 기술은 3D 영상의 성공과 함께 급속히 확산되었고, 이와 함께 3D 기술의 특성의 평가 및 표준화 활동은 활발하게 진행 중이다. 3D display에서 화면과 우안에서의 측정은 화면에 간단한 평가가 가능하나 외부, 우안의 상이 유효되며 입체 영상으로 인한 결과는 정확할 수 없다는 점에서 3D와 3D display의 측정에 차이가 있다.

17:30 T3C-Ⅲ 2 Dot sampling 기법을 이용한 공간 분할 방식 지방 처리 프로미터

In this paper, we will suggest a method to improve the perceived resolution of an autostereoscopic 3D display using spatial interlacing directional backlight system by adopting dot sampling technique.

17:45 T3C-Ⅲ 3 무안경식 입체 디스플레이에의 영향에 관한 연구

The viewing zone is formed by optical plate, such as parallax barrier in the autostereoscopic display and was verified by using simulation the effect due to the refractive index of the optical plate.

18:00 T3D-Ⅲ 4 3차원 영상 형식을 위하여 영상 획득 시스템과 괴적으로 동기

We present a multi-view display for 3D teleconference. This consists of plural projectors and retro-reflective screen and it is optically equivalent to the multi-view acquisition system.
Modeling of Si Micro-Ring Modulator Self-Heating

Yoojin Ban, Jinsoo Rhim, Byung-min Yu, Yunsu Sung, Jeong-min Lee and Woo-Young Choi*
Department of Electrical and Electronic Engineering, Yonsei University
wchoi@yonsei.ac.kr

Si photonics has a great potential for realizing cost-effective, high-bandwidth, and small-footprint optical interconnect systems\(^{1-2}\). The Si electro-optic modulator is one of the key components for Si photonic optical interconnect systems. In particular, a Si micro-ring modulator (Si MRM) is attracting a great amount of research interests as it can provide large bandwidth and high modulation efficiency with a small size and low power consumption\(^3\). An accurate model for the Si MRM is necessary for designing transmitters for optical interconnect applications. There are several dynamic models of Si MRM\(^4-5\). However, there is no Si MRM model that can include the self-heating effect. In this paper, we present a model based on the coupled-mode theory that includes self-heating of the Si MRM due to free carrier absorption (FCA). In addition, we confirm the accuracy of our model with measurement.

Figure 1 shows the structure of the Si MRM used for our investigation. Input light passing through the bus waveguide is partially coupled into the ring waveguide. Circulating light in the ring waveguide experiences phase shifts. Then, a portion of circulating light couples out to the bus waveguide and interferes with the uncoupled input light. Round-trip phase shifts are electrically tunable with an embedded reverse biased PN junction, which enables high speed operation. The figure also includes a microphotograph of the fabricated Si MRM. It is fabricated on 220-nm thick Si layer on 2-μm buried oxide layer through the OpSIS-IME multi-project-wafer foundry service.

From the coupled-mode theory, Si MRM dynamics can be modeled as\(^6\)

\[
\frac{da(t)}{dt} = (j\omega_0 - 1/\tau)a(t) - j\mu E'(t) \quad \text{and} \quad E'(t) = E(t) - j\mu a(t).
\]  

(1)

In the above equation, \(a(t)\) represents a total energy amplitude stored in the ring with resonance angular frequency \(\omega_0\). \(\omega_0\) is given as \(2\pi n_0 c/(n_0 L)\) with the mode number \(m\), the speed of light \(c\), the group index of the ring \(n_0\), and the ring circumference \(L\). \(E'(t)\) and \(E(t)\) represent input and output optical field, respectively, where \(E\) is given as \(E_0 \exp(j\omega t)\). \(\tau\) is the decay time constant satisfying \(1/\tau = (1 - \alpha^2 + \kappa^2) c/(2n_0 L)\), where \(\alpha\) represents the round-trip loss and \(\kappa\) is the coupling coefficient for the ring-bus coupler. \(\mu\) is the mutual coupling coefficient satisfying \(\mu^2 = \kappa^2 c/(n_0 L)\).
Since the optical power can be highly concentrated in the ring, thermal resonance shift due to two photon absorption (TPA) or FCA can be observed with high input power. In Si MRM with PN junction, it has been found that FCA is the dominant factor for thermal resonant shift\(^7\). Generated heat through FCA in the doped ring waveguide increases the refractive index of the waveguide. This becomes more pronounced closer to the resonance due to the higher optical power density, resulting in the skewed resonance peak. Group index of the ring \(n_0\) can be modeled as a function of \(|A(t)|^2\), the total optical power in a cross section of the ring waveguide as

\[
\eta(t) = n_0 + \sigma |A(t)|^2 = n_0 + \sigma |a(t)|^2 / T,
\]

where \(\sigma\) is a refractive index change coefficient and \(T\) is the round-trip time.

Eq. (1) can be numerically calculated with changing \(n_0\) in each time step. Figure 2(a) shows the measured transmission curves with different input optical powers as well as the calculated results obtained from Eq. (1). Extracted ring parameters from fitting the transmission curve at -10 dBm input power are \(\alpha=0.940\) and \(\kappa=0.235\). Refractive index change coefficient \(\sigma\) is extracted as \(7.8 \times 10^{-5}\) mW\(^{-1}\). Figure 2(b) shows the resonance wavelength shift which linearly depends on the ring input power.

In summary, we successfully modeled the self-heating effects of the Si MRM using the coupled-mode theory. Values for the refractive index change coefficient and ring parameters are extracted with measurement results. Simulations and measurements are in good agreement.

\[\begin{align*}
5 \text{ dBm} \\
0 \text{ dBm} \\
-5 \text{ dBm} \\
-10 \text{ dBm}
\end{align*}\]

Fig. 2. (a) Transmission curves with different levels of input laser power. (b) Resonance wavelength shift as a function of ring input power.

References