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LAMP presentations

ORAL ABSTRACTS

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Title:

Measurement of reflectivity of bonded interface in microchip laser cavity using scanning interferometry

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Abstract:

We present a method for measurement of residual reflectivity at the interface between two optically contacted components of microchip laser. The method is based on the analysis of the reflectance of a thermally scanned three-mirror Fabry-Perot interferometer. The small reflections at the interface between two parallel plates result in amplitude modulation of the temperature response of the interferometer. The modulation depth is directly related to the reflectivity of the interface. By fitting a calculated temperature response to the recorded data, value of the reflectivity is found. Measurement results for microchips with sub-millimeter aperture size are presented. Reflectivity of $2 \cdot 10^{-3}$ is determined.

Nanocrystalline metal-oxides based Fiber optic gas sensor for ammonia, methanol and ethanol sensing

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Abstract:

Metal-oxides such as SnO_2, ZnO, WO_3, are widely used for detecting toxic and pollutant gases like NH_3, NO_2, ethanol, methanol and acetone due to their excellent chemical and physical properties.

Metal-oxide sensors are, traditionally, of electrical resistive-type whose resistance varies when they are exposed to the detecting gas. However, these sensors exhibit enhanced gas sensitivity only at high operating temperatures (above 200^{o}C) and also respond to many gases (CO, methanol, NH3 and CH4). Hence, the gas sensitivity of metal oxide sensors are being improved by changing their physical properties, changing their size (nanomaterials) or exploring new type of sensors for ambient temperature operation and also for improved gas selectivity.

We have proposed a clad-modified fiber optic gas sensor using nano crystalline metal oxides (ZnO, SnO_2, TiO_2) as sensing medium for room temperature operation and also for improved selectivity. The study shows that the proposed sensor exhibits good gas sensitivity at ambient temperature and gas selectivity. This type of sensor may find potential applications in industry.

Self-organization of nanopatterns on the surface of azo-polymer films

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Abstract:

Our interest is in the area of self-organization of diffractive patterns in thin films of photochromic polymers. We have shown that illuminating the surface of an azo-polymer film with a single uniform laser beam, creates a well defined erasable (optically or thermally) patterns. The combination of one low power coherent laser beam with another high power incoherent and unpolarized beam can give rise to a well-defined surface relief grating induced in an azo-polymer film. It appears experimentally that the low power beam carries information which is transferred to the high power beam. This one creates the holographic structure on the surface of azo-polymer thin films.
Our experiments show that complex behaviors can be processed using simple systems: weak coherent light can serve as a seed to create information into a polymer film in such a way that molecules powered by incoherent light will build and transmit well defined complex structures. Moreover we have shown the concept of neurophotonics in which any of the nano-gratings can be erased and reconfigured.
In parallel to this study we also perform in two other research directions. First, we have modeled analytically the process of self-organization that leads to surface relief gratings. In the second one we continue the structuration of thin films aiming at a topographical control of the neuronal cells growth and at applications in the domain of biology.
The first results are promising and show that the patterns are bio-compatible and stable in aqueous media. We have observed the growth of neuronal cells following the surface relief gratings.
Currently the research is directed towards the study of the relaxation phenomena of self-organized nano-patterns on azo-polymer films.

S. Ahmadi Kanjani, R. Barille, S. Dabos-Seignon, and J.-M. Nunzi, E. Ortyl, S. Kucharski, '*Multistate polarization addressing using one single beam in an azopolymer film*', Optics Letters, Vol. 30, Issue 15, pp. 1986 - 1988 (2005).
R. Barille, J.-M. Nunzi, S. Ahmadi Kandjani, E. Ortyl, S. Kucharski, '*Cognitive ability experiment with photosensitive organic molecular thin films*', Phys. Rev. Lett., 97, 048701, (2006).
H. Leblond, R. Barille, S. Ahmadi-Kandjani, E. Ortyl, Stanislaw Kucharski and Jean-Michel Nunzi, '*A very simple model for the light-induced diffusion*', *J. Phys. B: At. Mol. Opt. Phys.* **42,** 205401, (2009).
Barillé, R ,Tajalli, P, Roy, P, Ahmadi-Kandjani, S, Kucharski, S, Ortyl, E, ' Hollow-core grating fiber', Optics Communications, Volume 285, Issue 4, 15 February 2012, Pages 468-472.
L. Mazaheri, S. Ahmadi Kandjani, *'Spontaneous nano pattern formation under pulsed exposure: relaxation kinetics study'*, Optical and Quantum Electronics, May 2012, Volume 44, Issue 1-2, pp 17-25.

Studying HIV-1 Protease folding pathways at the single molecule level using optical tweezers

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Abstract:

Optical tweezers (OT) is an established tool in the field of life sciences and enable us to revisit protein folding with a completely new approach. Protein folding is one of the major unsolved challenges for modern biophysics. Retroviral protease from human immunodeficiency virus type 1 (HIV-1-PR) is essential for the maturation of the virus and it has been identified as potential target for structure-based drug design. In present study, we used OT to investigate the folding pathways of HIV-1-PR at the single molecule level. The results of our experiments reveal that this protein reaches its native state following multiple folding routs characterized by different intermediate structures. The insight obtained from our measurements, which is consistent with the results of earlier molecular dynamic (MD) simulation studies, might help us design effective folding inhibitor drugs for HIV-1-PR.

Key words: Protein folding, single molecule, optical tweezers (OT), human immunodeficiency virus type 1 (HIV-1-PR).

Fabrication of a Femtosecond Er-doped Fiber Laser Based on Nonlinear Polarization Rotation Effect

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Abstract:

Er-dopped fiber laser at 1550nm wavelength band, 195MHz of repetition rate and pulse duration of about 125fs is fabricated. Nonlinear Polarization Rotation technique is used to mode lock the laser in a unidirectional cavity. Average output power of this laser at its 7^{th} harmonic is about 8mW which corresponds to 41pJ of pulse energy. For its fundamental Harmonic, pulse energy and the repetition rate are 320pJ and 27.8MHz, respectively.

Determining the more precise values of nonlinear indices of refractions in *Z*-scan experiments

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Abstract:

We have extended the basic Sheik-Bahae formalism to include the possibility of nonlocal response of samples in Z-scan experiments [1]. The basic formulation of the Sheik-Bahae formalism has been extended by incorporating a nonlocal parameter in the Gaussian phase shift induced by the self-phase modulation effect. Using this kind of phase shift, we have proposed a simple method for interpreting the Z-scan results when the sample response is nonlocal. In our proposed method, the order of nonlocality (the *m* parameter) and the nonlinear index of refraction n_2 of thin samples can easily be determined by measuring the peak-to-valley separation distance and transmittance difference of their Z-scan curves. Knowing the order of nonlocality can be quite useful in determining the more precise values of n_2 in Z-scan experiments.

[1] M.R. Rashidian Vaziri, F. Hajiesmaeilbaigi and M.H. Maleki, *J. Opt.* **15** (2013) 025201.

Control of second-harmonic generation in silver nanowires

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Abstract:

The goal of ultrafast nanooptics is shaping the electric field at the nanometer spatial scale and the femtosecond temporal scale through the controlled excitation of optical resonances in metallic nanostructures [1]. Experiments on nanowires allow one to consider Fabry-Perot resonances that are based on propagation effects. We excite silver nanowires with pulse trains; we observe second-harmonic generation from the metal structures [2] as a function of pulse train parameters and demonstrate that the coherent control of harmonic generation reflects the characteristics of the resonance.

[1] M.I. Stockman, S.V. Faleev, and D.J. Bergman; Coherent control of femtosecond energy localization in nanosystems; Phys. Rev. Lett., **88**, 067402 (2002).

[2] M. Zavelani-Rossi et al.; Near-field second-harmonic generation in single gold nanoparticles; Appl. Phys. Lett., **92**, 093119 (2008).

Femtosecond laser research in Syria; construction of FemtoLab

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Abstract:

Implanting femtosecond technology in a developing country like Syria is a very tough task. Second harmonic generation SHG, Sum-Frequency Generation and Coherent anti-Stokes Raman spectroscopies with microscopy applications are very attractive nowadays; by which a femtosecond research lab is under construction.
In this project, a chirp pulse amplification system should be build and consists of a Ti:Sapphire femtosecond oscillator, pulse stretcher, two or three successive amplification stages and finally pulse compressor in order to achieve high energy amplified optical pulses in femtosecond duration. A part from the first amplification stage can be used to pump the SFG sample in which the SFG signal from a small sample region will be collected by a special optical objective and visualized by high sensitivity CCD camera. The latter setup will be devoted to study the dynamics of biomolecules/biosensors using femtosecond time resolution.

Passively mode-locked Master Oscillator Power Amplifiers

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1. Introduction and background

High power mode locked lasers (SMLLs) are important sources for optical fiber communication systems, optical sampling, non-linear frequency conversion and signal processing [1]. The maximum output power obtained from the SMLLs is limited due to non-linear relation between the optical field, carrier density and refractive index, and this leads to pulse phase modulation and mode locking instabilities. Various schemes for getting high output power from SMLLs are lasers array [1], bowtie gain regions [2], tapered waveguides [3], master oscillator power amplifiers (MOPAs) [4] and slab coupled optical waveguides (SCOWLs) [5].

2. The Principle

We report on the fabrication and characterization of high output power mode-locked semiconductor lasers monolithically integrated with semiconductor optical amplifiers (SOAs). These integrated devices were fabricated using 1.5 μm AlGaInAs/InP epitaxial material, which have a three quantum well active region and a far field reduction layer in the n-cladding layer. These devices were operating at repetition rate of 40 GHz. The highest average output power of 200 mW with a corresponding output peak power of > 1.2 W was achieved from a semiconductor mode locked laser integrated with a 2° tapered SOA.

3. Wider implications and Characteristics

The MOPA concept was used for achieving high output power from semiconductor lasers. We monolithically integrated SMLLs with single transverse mode ridge waveguide SOAs and tapered SOAs of different taper angles, respectively. The effect of the integration of different types of SOAs on the output power and the mode locking performance of these devices are investigated. An average output power of 130 mW and peak power > 1W was obtained from a SMLLs monolithically integrated with single mode SOAs. For further increase in the output power, we integrated 2° tapered SOAs at the output of SMLLs and obtained an average output power of 200 mW with corresponding peak power of 1.2 W. We also integrated a 6° tapered SOA at the output of a SMLL, which gives a maximum output power of 105 mW under CW current conditions. The lower output power obtained from 6° tapered SOA devices is due to the increased heating effects due to high CW current requirement . It is anticipated that these devices would exhibit better output power performance in pulsed current operation.

4. References

[1] A. Mar, R. Helkey, T. Reynolds, J. Bowers, D. Botez, C. Zmudzinski, C. Tu, and L. Mawst," Mode-locked multisegment resonant-optical-waveguide diode laser arrays" *IEEE Photon. Technol. Lett*. 5(12), 1355, (1993).

[2] S. Gee, G. Alphonse, J. Connolly, and P. J. Delfyett," High power mode-locked external cavity semiconductor laser using inverse bow-tie semiconductor optical amplifiers" *IEEE Journal of Selected Topics in Quantum Electronics*, 4(2), 209, (1998).

[3] D.I. Nikitichev, Y. Ding, M. Ruiz, M. Calligaro, N. Michel, M. Krakowski, I. Krestnikov, D. Livshits, M.A. Cataluna, E.U. Rafailov, "High-power passively mode-locked tapered InAs/GaAs quantum-dot lasers" Applied Physics B: Lasers and Optics. 103(3), 609, (2011).

[4] Jehan Akbar, Lianping Hou, Mohsin Haji, Michael J. Strain, John H. Marsh, A. Catrina Bryce, Anthony E. Kelly, "High power (130 mW) 40 GHz 1.55 m mode-locked distributed Bragg reflector lasers with integrated optical amplifiers," *Opt. Lett*. 37, 344 (2012).

[5] J. J. Plant, J. T. Gopinath, B. Chann, D. J. Ripin, R. K. Huang, and P. W. Juodawlkis, "250 mW, 1.5 _m monolithic passively mode-locked slab-coupled optical waveguide laser" Opt. Lett. 31, 223, (2006).