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Invited Seminar

Dr. Jer-Shing Huang

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Plasmonics for Enhancing Nanoscale Light-matter Interaction: Applications in Optical Manipulation and Chiral Analysis

Date: Tuesday, 10 May 2016

Time: 3:00 p.m. – 4:00 p.m.

Place: ECS 660

Abstract

Chirality of a molecule is of critical importance since it determines the medical functions and biological activity of drugs and proteins. Unfortunately, chiral light-matter interaction is typically weak due to the length mismatch between the wavelength of light and the molecular chiral domain. For example, circular dichroism (CD) based on the coupling between induced electric dipole and magnetic dipole moment is weak because plane waves cannot efficiently excite the magnetic dipole moment. Plasmonic nanostructures can concentrate and control optical fields at nanometer scale [1] and provide stiff optical potential to manipulate nanoobjects [2]. Plasmonic nanostructures offer possibility to engineer optical near fields and enhance light-matter interaction at the nanometer scale. Recently, it has been shown that optical near fields can be designed to selectively enhance the CD of chiral molecules [3]. Achieving the desired enhancement requires the presence of chiral targets in the area of the pre-designed field. In my lecture, I will discuss recent advances in optical field engineering for enhancing chiral light-matter interaction, including our new design of slant-gap nanoantenna and elliptical nanoholes for simultaneous optical trapping and CD enhancement. The proposed nanostructures can be easily realized by standard nanofabrication techniques and the excitation scheme can be readily achieved by common optical laboratory. The latest research progress on several different related topics, including mode conversion in optical nanocircuits [4] and plasmonic solar cells [5] will also be given in the lecture.

References

1. Biagioni, P.; Huang, J.-S.; Hecht, B. “Nanoantennas for visible and infrared radiation,” *Rep. Prog. Phys.* **2012**, *75*, 024402.

2. Tsai, W.-Y.; Huang, J.-S.; Huang, C.-B. “Selective Trapping or Rotation of Isotropic Dielectric Micro-Particles by Optical Near Field in a Plasmonic Archimedes Spiral,” *Nano Letters* **2014**, *14*, 547–552.

3. Lin, D.; Huang, J.-S. “Slant-gap plasmonic nanoantennas for optical chirality engineering and circular dichroism enhancement,” *Opt. Exp.*, **2014**, *22,* 7434–7445.

4. Dai, W.-H.; Lin, F.-C.; Huang, C.-B.; Huang, J.-S. “Mode conversion in high-definition plasmonic optical nanocircuits,” *Nano Letters* **2014**, *14*, 3881–3886.

5. Liu, W.-L.; Lin, F.-C.; Yang, Y.-C.; Gwo, Shangjr; Huang, M. H.; Huang, J.-S. “The influence of shell thickness of Au@TiO_2 core-shell nanoparticles on plasmonic enhancement effect in dye-sensitized solar cells,” *Nanoscale* **2013**, *5*, 7953–7962.

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Biography

Dr. Jer-Shing Huang is currently an associate professor leading an independent research group of nanooptics in the Department of Chemistry at National Tsing Hua University (NTHU). Dr. Huang's research focuses on the engineering of optical fields at nanoscale for specific light-matter photochemical and photophysical interaction. Dr. Huang obtained his PhD from the Department of Chemistry at National Taiwan University in 2004. His PhD research is about gas-phase plasma and atomic emission spectroscopy. Dr. Huang then joined the Institute of Atomic and Molecular Science at the Academia Sinica in Taiwan, where he studied the dynamics of interfacial electron transfer in dye sensitized solar cells using single-molecule microscopy. In 2007, Dr. Huang joined Prof. Dr. Bert Hecht's group in the Department of Experimental Physics 5 at the University of Würzburg in Germany. During this period, he was the first to describe the impedance matching and emission properties of an optical nanoantenna in a complete integrated optical nanocircuit. He also developed a novel hybrid fabrication method to produce high-definition single-crystalline plasmonic nanostructures using chemically synthesized gold flakes. In 2010, Dr. Huang joined the Department of Chemistry at the National Tsing Hua University in Taiwan and started his independent research on the engineering of nanoscale light-matter interaction. Dr. Huang was the winner of NTHU New Faculty Member Research Award in 2014 and received the Gold-Jade Fellowship in 2015. Dr. Huang currently serves as a guest editor for *ACS Photonics*. According to Thomson Reuters Web of Science (Apr. 2016), Dr. Huang's current *h*-index is 19.

Selected Publications

1. "Single-Crystalline Aluminum Nanostructures on a Semiconducting GaAs Substrate for Ultraviolet to Near-Infrared Plasmonics" Liu, H.-W.; Lin, F.-C.; Lin, S.-W.; Wu, J.-Y.; Chou, B.-T.; Lai, K.-J.; Lin, S.-D.; **Huang, J.-S.*** *ACS Nano* **2015**, *9*, 3875–3886.
2. "The Modulation Effect of Transverse, Antibonding, and Higher-Order Longitudinal Modes on the Two-Photon Photoluminescence of Gold Plasmonic Nanoantennas" Chen, W.-L.; Lin, F.-C.; Lee, Y.-Y.; Li, F.-C.; Chang, Y.-M.; **Huang, J.-S.*** *ACS Nano* **2014**, *8*, 9053-9062.
3. "Mode conversion in high-definition plasmonic optical nanocircuits" Dai, W.-H.; Lin, F.-C.; Huang, C.-B.; **Huang, J.-S.*** *Nano Letters* **2014**, *14*, 3881-3886.
4. "Slant-gap plasmonic nanoantennas for optical chirality engineering and circular dichroism enhancement" Lin, Daniel; **Huang, J.-S.*** *Optics Express* **2014**, *22*, 7434-7445.
5. "Transport and trapping in two-dimensional nanoscale plasmonic optical lattice" Chen, K.-Y.; Lee, A.-T.; Hung, C.-C.; **Huang, J.-S.***; Yang, Y.-T.* *Nano Letters* **2013**, *13*, 4118-4122.
6. "Nanoantennas for visible and infrared radiation" Biagioni, P.; **Huang, J.-S.**; Hecht, B.* *Rep. Prog. Phys.*, **2012**, *75*, 024402.
7. "Atomically flat single-crystalline gold nanostructures for plasmonic nanocircuitry" **Huang, J.-S.***; Callegari, V.; Geisler, P.; Brüning, C.; Kern, J.; Prangsma, J. C.; Wu, X.; Feichtner, T.; Ziegler, J.; Weinmann, P.; Kamp, M.; Forchel, A.; Biagioni, P.; Sennhauser, U.; Hecht, B.* *Nature Communications*, **2010**, *1*, 150.