Chao LU

CONTACT

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RESEARCH INTERESTS

Quantum Optics; X-Ray Laser; Surface Enhanced Raman Scattering (SERS); SERS fiber sensor.

EDUCATION

Princeton University, Princeton, NJ, USA

PhD student in MAE Department.

- Majored in applied physics, minor in applied mathematics.
- Subject components passed.
- Courses requirements (4 physics and 4 math) finished.
  MAE521: **A** (Optics and Lasers).
  CHM501: **A** (Introduction to Quantum Chemistry).
  CHM502: **A** (Advanced Quantum Chemistry).
  MAE527: **B** (Physics of Gases).
  MAE501: **A** (Mathematical Methods of Engineering Analysis I).
  MAE502: **A** (Mathematical Methods of Engineering Analysis II).
  PHY403: **A** (Mathematical Methods of Physics).
  CEE525: **B** (Applied Numerical Methods).
- Working with Prof. Marlan O. Scully(Fellow, National Academy of Science, USA)

Tsinghua University, Beijing, PRC

M.S., Optical Engineering, 2008

- Thesis Topic: SERS Fiber Probe Optimization and Application.
- Advisor: Prof. Guofan Jin (Fellow, National Academy of Engineering, China) and co-advisor: Prof. Claire Gu.

B.S., Mechanical Engineering, 2005

- Emphasis on Control engineering and Measurements.

PUBLICATIONS

Chao LU, Claire Gu, Guofan Jin, et al. "Collectible optical power of various specially shaped multimode optical fiber probes for contact sensing", Opt. Eng., Vol. 47, 010502 (2008).

Chao Shi, **Chao LU**, Claire Gu, et al. "Inner Wall Coated Hollow Core Waveguide Sensor based on Double Substrate Surface Enhanced Raman Scattering", Appl. Phys. Lett., Vol. 93, 153101 (2008)

CONFERENCE

Poster: "Preliminary data and results on emission and absorption by excited He atoms", Quantum Electrodynamics Conference 2010, Casper, WY.

Poster: "Substrates considerations for surface-enhanced CARS", Quantum Electrodynamics Conference 2009, Jacksonhole, WY.

ACADEMIC EXPERIENCE

2009-Currently **Princeton University**

Using quantum coherence to generate gain in the XUV and X-Ray

- A strong femto-second laser pulse ($800nm$, $10^{15}W/cm^2$, $100fs$ pulse width) was directed to Helium gas (atom density:$10^{18}cm^{-3}$). The atoms will be fully ionized in this optical field (E: $10^8V/m$), and plasma is created. Due to collisons, ionized electrons will repopulate all the energy levels of Helium in nanoseond time scale. Then with beams from OPA directed to the gas, whose wavelengh matches the energy difference of levels intersted, the coherence in the atoms are created. With the presence of coherence,the lasing without inversion scheme is created. Finally a transint lasing gain without population inversion between 2^1P and 2^1S was expected, whose wavelength is $58nm$.

2005 - 2008 **Tsinghua University**

Variously shaped multimode fiber SERS sensor

- Multimode fibers with various shapes (conic, parabolic, spherical...) served as a SERS sensor.
- A model was set up to calculate the impact on detection signal by the shape variations.
- Simulation code based on the physical model was developed, and experiments were performed, to verify of the model.
- One paper was published based on this work.

Liquid Core PCF sensor based on SERS

- Developed a novel procedure using a fusion splicer to seal the PCF, then the liquid core SERS sensor was prepared based on the sealed fiber.
- A double SERS substrate "sandwich" structure was utilized, with one substrate coated on the inner wall of the PCF and the other mixed in the sample solution.
- The combination of these two novel detection schemes provided a two magnitude of enhancement.
- A paper based on this observation was published.

Preparation of tapered SERS fiber

- The tapered fiber sensors were etched by hydrofluoric acid (HF). Relationships between the desired shapes of the tapered fiber, the etching time and concentrations of HF were explored. We were able to produce a fiber sensor with optimized shape parameters.
- SERS detections for analyte R6g with tapered Sensors were carried out, results were present and discussed.

'Bowl shape' Enhancement

- A novel bowl shape was fabricated by fusion splicer at one end of the PCF sensor.
- This bowl shape provides an extra 10 times enhancement of the detectable signal.
- Meep simulation was employed to calculate the optical field distribution.
- Mie scattering simulation, with code in Fortran was used.

Technical Skills

Programming: C, Shell scripting, Python, Lisp.
Math Tools: Matlab, Mathematica.
Unix Tools: Emacs, LaTeX, SVN, Unix toolkits (grep sed etc.)
3D Modeling: AutoCAD, Pro/E, Solidworks.
Optical Tools: Meep(FDTD), Oslo.