MAR09-2008-007163

Abstract for an Invited Paper
for the MAR09 Meeting of
the American Physical Society

Ultrafast and Quantum Nanoplasmonics: SPASER and Control

MARK I. STOCKMAN, Department of Physics and Astronomy, Georgia State University

Nanoplasmonics is presently experiencing a period of unprecedented growth and has numerous applications. These include sensing and detection of minute amount of chemical and biological objects for biomedicine and defense [1], near-field scanning optical microscopy [2], immunological tests, labels for biomedical research, nanoantennas for efficient coupling of light to semiconductor devices, etc. Nanoplasmonics still greatly needs active elements to generate optical energy on the nanoscale and serve as amplifiers. We have proposed a quantum nanoplasmonic generator and amplifier of the local optical fields, SPASER [surface plasmon amplification by stimulated emission (of radiation)]. [3-5]. A SPASER is analogous to laser except that light (photons) is replaced by local optical fields (surface plasmons). This is responsible for the principal difference: laser cavity must support photonic modes and its size is on order or much greater than the optical wavelength, cf. [6]. In contrast, the surface plasmons in the spaser are purely electric oscillations whose localization size is nanometric. SPASER will transform nanoplasmonics the same way as the laser transformed optics. In particular nanoplasmonic processors working at THz operation rates will become possible. Another important area is the active control of nanoplasmonic phenomena. One approach to it is coherent control, where a shaped optical pulse dynamically, on the femtosecond scale controls the nanoscale distribution of local fields [7-12].

References

[1] J. N. Anker *et al.*, Nature Materials **7**, 442 (2008).
[2] L. Novotny, and B. Hecht, *Principles of nano-optics* (Cambridge University Press, Cambridge, New York, 2006).
[3] D. J. Bergman, and M. I. Stockman, Phys. Rev. Lett. **90**, 027402 (2003).
[4] K. Li *et al.*, Phys. Rev. B **71**, 115409 (2005).
[5] M. I. Stockman, Nature Photonics **2**, 327 (2008).
[6] M. T. Hill *et al.*, Nature Photonics **1**, 589 (2007).
[7] M. I. Stockman, S. V. Faleev, and D. J. Bergman, Phys. Rev. Lett. **88**, 67402 (2002).
[8] M. I. Stockman, D. J. Bergman, and T. Kobayashi, Phys. Rev. B **69**, 054202 (2004).
[9] M. I. Stockman, and P. Hewageegana, Nano Lett. **5**, 2325 (2005).
[10] M. Durach *et al.*, Nano Lett. **7**, 3145 (2007).
[11] M. I. Stockman, and P. Hewageegana, Appl. Phys. A **89**, 247 (2007).
[12] X. Li, and M. I. Stockman, Phys. Rev. B **77**, 195109 (2008).