

ULTRACOMPACT SUB-WAVELENGTH PLASMONIC CAVITY
RESONATOR ON A NANOWIRE

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An electromagnetic cavity resonator with deep sub-wavelength size is considered theoretically on plasmonic nanowires with the permittivity modulated periodically. In this work, plasmonic nanowires are treated as cylindrical waveguides made of materials with negative permittivity in a certain band of frequency (such as silver or gold nanowires), and their dispersion characteristics are briefly reviewed first. In such waveguides, due to the negative value of the real part of permittivity, a slow-wave TM mode with no cut-off radius is present, i.e., even for a very small radius, this TM mode with the guided wavelength much smaller than the free-space wavelength is tightly bound to the nanowire. These epsilon-negative cylindrical waveguides (ENG CW) with periodically varied permittivity is then studied analytically using the space harmonic method. Dispersion relations for this slow guided mode inside and outside the band gap are calculated numerically, and evanescent modes near the center of band gap are studied in details. By properly creating a defect on such a sub-wavelength periodically modulated ENG CW (PM-ENG CW), a cavity on this nanowire can be synthesized whose dimension along the nanowire is determined by the guided wavelength and the decay rate of the evanescent mode, resulting in an ultracompact cavity resonator with a size much smaller than the free space wavelength. This size can be made even smaller by reducing the nanowire radius, since the thinner the wire radius, the shorter the guided wavelength and the higher the decaying constant. The effective size of this cavity is calculated numerically, and Finite Element Method (FEM) is used to demonstrate the cavity mode. The quality factor (Q) of such an ultracompact resonating mode is discussed. It was found that the material loss, more than the radiation leakage, is a determining parameter in Q evaluation. Candidate materials, e.g., some of the noble metals, suitable for making this structure are suggested and method of realizing such a resonating structure using only one material is also mentioned. Finally, the quantum limit of this theory is also discussed.

Abstract Submission Form

2006 National Radio Science Meeting

Abstract: li1303

Date Received: September 17, 2005

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2. B - Fields and Waves

3. (a) SB1

4. I - Invited Paper

5. No special instructions