Infrared Antennas and Frequency Selective Surfaces

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We fabricate nanoscale electromagnetic structures resonant at infrared frequencies using direct-write electron-beam lithography. Planar lithographic antennas in the infrared portion of the spectrum have a number of unique characteristics. Incident radiation induces IR-frequency current waves to flow in the arms of the antenna, and places an IR-frequency sinusoidal voltage across the sensor element. The resonant frequency is determined by antenna dimensions rather than by sensor-material characteristics, and the specific antenna design allows tailoring of the spectral bandwidth around the center frequency. We also explore the issues of augular response, polarization, collection area, and impedance matching; along with the electron-beam lithographic processes required for fabrication, and on the procedures for performance characterization of the IR antennas. We also have ongoing investigations of IR frequency selective surface (FSS) technology. The resonant frequency and spectral bandwidth of the FSS are controlled by the geometry of the metallic structures in the periodic surface. A particularly interesting feature of the IR FSS is the ability to control the spectral absorption, and hence by Kirchoff's Law – spectral emissivity. In the design process for both IR antennas and IR FSS, we find that knowledge of the spectral variation of real and imaginary parts of dielectric constant is crucial for accurate agreement between numerical models and measured results. This is particularly important for the thin metallic films comprising the antenna arms and the FSS structures, for which inadequate tabular data is available in the literature. Optical properties are measured with an IR variable angle spectroscopic ellipsometer (IR VASE), then imported into full-wave models for design and analysis. Designs for specific infrared antennas and FSSs are developed by an integrated approach of modeling, fabrication, and testing.

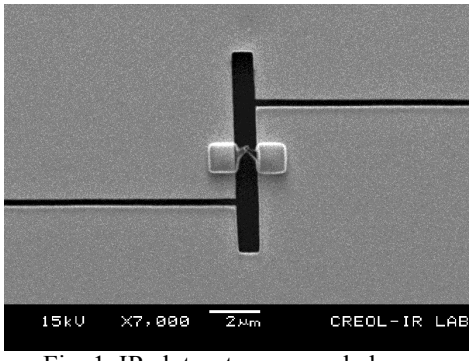

Fig. 1. IR slot-antenna-coupled sensor.

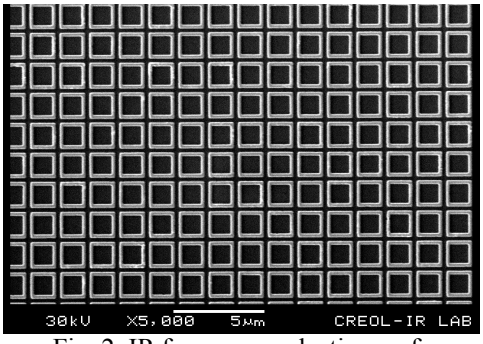

Fig. 2. IR frequency-selective surface.