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The photon propagation paradox, ultrathin condensers, and plasmonic dual-space nanoscopes

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Excitation, detection, and control of surface plasmon polaritons (SPP) have found numerous practical applications. However, SPPs are also invaluable for understanding the nature of light. Does single-photon SPPs exist? Do photons describe trajectories when they move? Do photons follow the lines of electromagnetic energy flow? Do photons pass through all points between point A and point B when they travel from A to B? These and others basic questions that are explored in the experiments with SPPs described here. In this experiment, SPPs are excited on a sample fabricated in top of a coverslip. An inverted microscope with two cameras is used for obtaining the images that are formed in the real and Fourier plane of the microscope. The light used for imaging is leakage radiation associated to the excited SPPs. In addition, it is discussed how the discovery of plasmonic ultrathin condensers in combination with dual-space microscopy, a novel phase-recovery imaging technique based on the dual observation of the sample in the position and momentum spaces, may conduct for the development of plasmonic dual-space nanoscopes.

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Super-luminescence in wide bandgap nitride semiconductors

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Speed of light in vacuum (c = 3 x 108 m/s) is the fastest speed in the universe as described in the Einstein Theory of Special Relativity. This is the upper limit of motion and no material object can reach this speed. When light travels through a transparent material, its speed decreases and it takes longer time to transit than the time it takes to travel the same length in vacuum. The ratio of the speed of light in vacuum and the speed of light inside a material gives an optical property of the material called index of refraction or refractive index 'n'. Since the speed of light in a material is less than its vacuum speed therefore $n \geq 1$. A material, in which light moves faster than its vacuum speed, is called a super-luminescent material. A material becomes super-luminescent if it's $n<1$.Thin films of pure AlN and AlN doped with Ho+3 and Gd+3 are deposited by RF magnetron sputtering. The deposited films are amorphous and their thickness varies between 50 nm and 400 nm. These films are investigated for their optical properties and index of refraction using ellipsometric techniques. The index of refraction of pure AlN is found to be 1.95. The index of refraction of Ho (less than 1%) and Gd (less than 1%) doped AlN is observed to be slightly lower than pure AlN. The concentration of Gd dopant is increased several times. The increasing concentration of Gd kept lowering the refractive index of AlN. When the concentration of Gd dopant increased to 5 times its initial concentration of 1 %, the index of refraction of AlN dropped below 1. The value $n<1$ clearly makes AlN a super-luminescent material. Work is in progress to see the effect of increasing Gd concentration on the optical properties of other nitride semiconductors.

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