Ultra-Broadband Absorption in Metallic Gratings at the 'Plasmonic Brewster Angle'

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In this talk we review the recently proposed concept of 'plasmonic Brewster angle' [A. Alù, et al., Phys. Rev. Lett. 106, 123902 (2011)] and apply it to the design of ultrabroadband absorbers for THz and infrared radiation. Particular emphasis will be given to these energy harvesting potentials and interesting directional thermal emission properties. We will demonstrate that it is possible to realize ultra-broadband funneling, concentration and absorption of the impinging radiation within a one-dimensional (1D) subwavelength plasmonic grating, which is followed by an elongated adiabatically tapered plasmonic waveguide which can absorb light over a broad wavelength range. This effect is achieved in an angular range near the Brewster funneling condition, in analogy to the well-known Brewster transmission for ordinary dielectric etalon interfaces. Compared to conventional Brewster transmission, the plasmonic grating provides more degrees of freedom in patterning the angular response and the addition of elongated plasmonic tapers may extend this mechanism to almost omnidirectional broadband absorption at THz, infrared (IR) and optical frequencies with several interesting potential applications. These concepts will be generalized to two-dimensional (2D) plasmonic screens and analytical, numerical and experimental results will be demonstrated.

Note that the proposed concept is non-resonant, since it is based on impedance matching between oblique incidence radiation and a plasmonic grating interface, leading to zero reflection and almost total ultrabroadband absorption of energy. Nonetheless, this anomalous tunneling effect is valid only for transverse-magnetic (TM) polarized radiation. It can lead to large concentration of electromagnetic radiation inside the channels, with a totally different nature compared to usual resonant funneling mechanisms, based on Fabry-Perot resonances and other extraordinary optical transmission (EOT) concepts.

Since absorption and thermal emission are related and reciprocal concepts, we can apply similar designs to realize selective thermal plasmonic emitters, based on the aforementioned 1D and 2D metallic gratings. These directional thermal emitters can selectively transmit broadband blackbody radiation, and they may be designed to focus the emitted energy in specific narrow angular ranges around the Brewster angle of each plasmonic grating design. Novel directional thermal sources will be demonstrated, which may operate at IR and even optical frequencies.