Active Control of Infrared Thermal Emission with Tunable Metafilms and Metasurfaces

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Selective control of thermal emission and absorption has numerous applications in energy harvesting, thermal management, and optoelectronics. Past work has demonstrated that surface radiative properties can be successfully tailored with multilayer structures and micro/nanostructures. However, reported radiative properties are mostly static, while active tuning of surface emission or absorption is greatly beneficial to radiative thermal control. In this invited talk, we will discuss our recent progresses in dynamic control of thermal radiation with thermally-controlled metafilms and electrically-gated metasurfaces. VO2, which experiences metal-insulator transition at 68 ^{o}C, was successfully fabricated with a furnace oxidation method. By depositing 25 nm thin-film VO2 on a sputtered silicon spacer and Al ground plane, it forms a Fabry-Perot resonant cavity when VO2 is at the metallic phase. As a result, thermal emission in the mid-infrared is much enhanced when the VO2 metafilm is heated above the phase transition temperature, while the surface is quite reflective with insulating VO2 at lower temperatures. Spectral emittance of fabricated VO2 metafilm samples measured by a Fourier transform infrared (FTIR) spectrometer coupled with a heating stage at different temperatures will be presented. Such a “smart” radiative coating with thermally controlled infrared emission could find applications in radiative cooling for buildings and spacecraft. Besides, we have recently fabricated a SiC metasurface, which exhibits wavelength-selective infrared emission due to magnetic phonon polariton. By coating the SiC metasurface with monolayer graphene, our numerical modeling has shown that the infrared emission peak can be tuned by varying graphene chemical potential with electrical gating. Experimental characterization with an FTIR microscope of such a novel tunable coherent thermal emitter under different gate voltages will be reported.