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Measuring Infrared Reflectivity of 3D Microantennas

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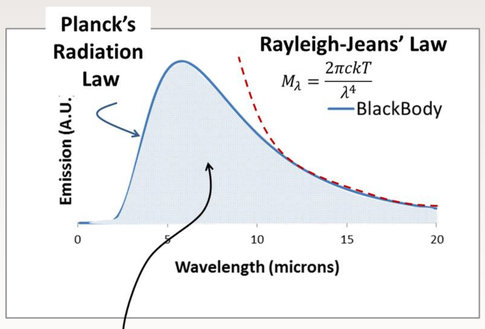
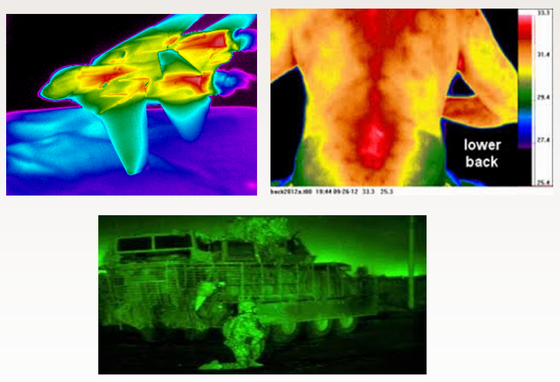
Objective: Understand the optical properties of 3D microstructures to be used in infrared applications

Background: All bodies emit thermal (IR) radiation according to Planck's law:

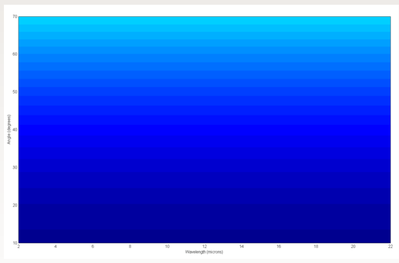


Stefan-Boltzman's Law

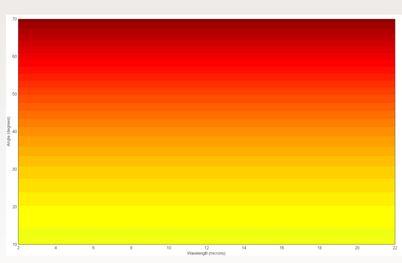
$M = \int_0^\infty M_\lambda d\lambda = \sigma T^4$ (total emitted power goes as T^4)



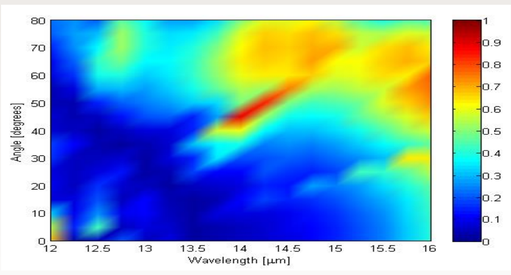
Example Reflection map for an unstructured absorptive Surface



Example Reflection map for an unstructured reflective Surface

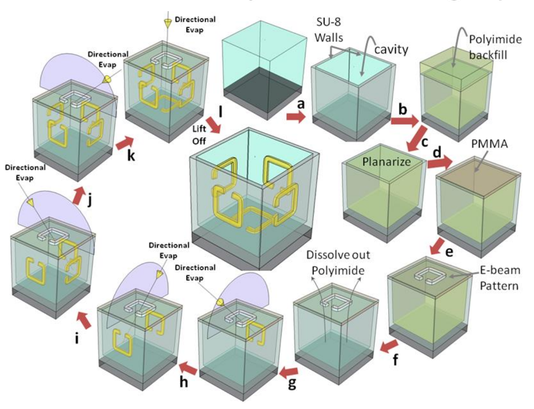


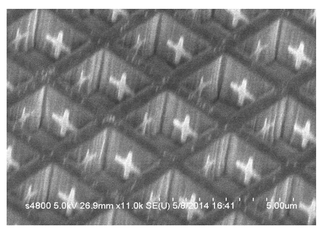
Example Reflection map for A structured electromagnetic material created with MPL

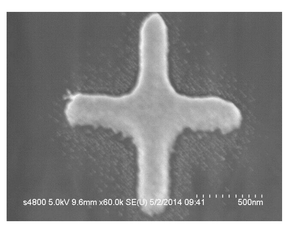


Applications which leverage IR radiation find use in night vision and other military technology, medical diagnostics, and more

Membrane Projection Lithography







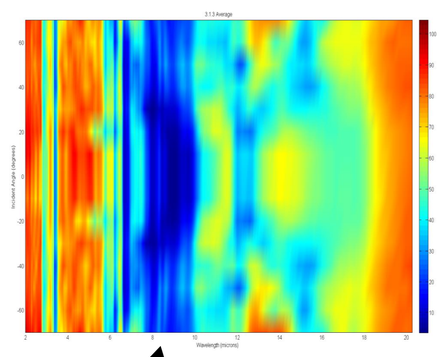
The ability to fabricate 3D micron-scale structures allows us to interact with IR light in new ways

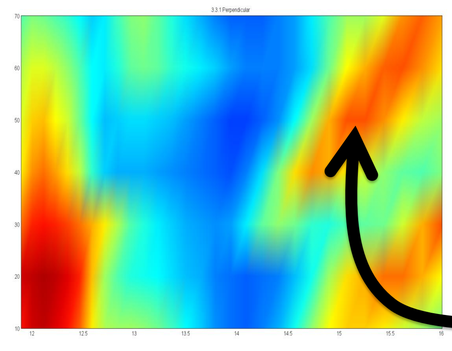
$$1 = R + T + A$$

Kirchoff's Law: Absorption and emission are equivalent, so with $T = 0$ we can use reflectance measurements to find information about emissivity

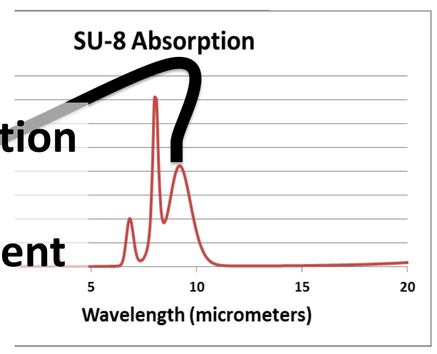
HDR/FT-IR setup used to measure reflectance of surfaces

Measured Reflectance Data of Structured Electromagnetic Surfaces Generated with MPL





Material absorption is angle independent



Properly designed metallic inclusions allow for the possibility of control over both angular and wavelength dependent Reflectivity/absorption

Angle-dependent reflectance suggests potential to engineer surfaces that emit radiation in a particular direction – a behavior not possible with natural unstructured materials.

Future work: Optimize designs for the metallic inclusions to target specific angle and wavelength combinations specific to application needs.

U.S. DEPARTMENT OF ENERGY

National Nuclear Security Administration

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