Center for Soft Matter and Biological Physics

Discussion Meeting

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"Investigation of the Gold-Black Absorption Mechanism"

Friday, October 5, 2018

4:00 pm—5:00 pm

304 Robeson Hall

The material called gold-black is an absorptive material frequently used in various thermo-detector. The advantages of gold-black that make it preferable over the other absorptive material is that it has the absorptivity almost one ($a = 1$) in the visible and infrared range which means that it absorbs all the radiation incident on it and appears black in an observer's eye. For this unique property gold-black has been used in thermal detector such as in micro-bolometer. The micro-bolometer converts the incident radiation to an electrical signal. Gold-black is used as a coating on the micro-bolometer to ensure a 100% absorption of the radiation. Micro-bolometer with gold-black coating has several applications specially in various program of Earth Radiation Budget where the global warming is closely monitored with satellite having micro -bolometer attached on it. The purpose of this effort is to establish a model of gold-black so that it can be used more efficiently in various detector.

We seek a first-principle model for predicting the spectral absorptivity of gold-black. Gold-black has been widely used in various thermal and optical applications for more than a century. In most relevant contributions to the literature, gold-black is treated as a homogeneous layer whose behavior is governed by its bulk optical properties. However, on the microscopic level gold-black more closely resembles a fuzzy layer of moss or a miniature forest. This suggests that the optical behavior of gold-black can be better characterized by taking into account its actual morphology.

We propose to model a layer of vacuum-deposited gold-black as a "fractal forest" where each branch of each tree is isolated and considered as an individual building block. In this treatment each individual branch acts as a dipole antenna with the forest as a whole behaving as a random-fractal antenna array. The approach of the current effort is to develop a model for the conversion of incident electromagnetic (EM) radiation to sensible heat by an individual branch behaving as a lossy antenna. The output of such a model would be the energy conversion efficiency (absorptivity), corresponding to a given wavelength, of a single branch having a specified length, diameter, and orientation with respect to incident EM radiation. The overall absorptivity of the forest at that wavelength would then be based on the statistical description of the spatial and angular distributions of branches of various length and diameter. The required statistical rules would be derived from microscopic study of actual gold-black layers.