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# Laser-induced thermal effects in optical interference coatings

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Optical interference coatings are commonly used for a large panel of optical components for Space applications. Once submitted to a laser illumination, a small amount of the laser energy is absorbed by the filter materials, which induces a rising temperature inside the component and therefore a change in its thermal radiation. These laser-induced thermal effects are a major issue in the field of Space communication or defense. In this paper, we develop a theoretical model to obtain the temporal and spatial evolution of these effects for a wide range of optical sources and components.

In order to obtain the laser induced temperature, the heat equation with the absorption density of the coatings for the source term is solved with an original analytical method based on the Fourier Transform and an analogy between optical propagation and heat diffusion. This allows us not only to obtain the spatial and temporal evolution of the temperature as a function of laser and components parameters, but also to determine laws to predict the maximum temperature elevation, which is a major information for the user and enables to study the nature, thermal or dielectric, of the laser-induced damage threshold.

The rising temperature inside the filter will modify its thermal radiation. This thermal effect is modeled by representing the thermal agitation of charged particles by electric current densities. These currents, which are related to the temperature elevation by statistical tools, are then introduced in Maxwell's equations to get the spectral, temporal, and angular patterns of the thermal radiation of arbitrary optical filters submitted to different optical sources.

The patterns of thermal radiation of optical interference coatings are generally closed to those of the blackbody apart from their very low level due to the low absorption of the materials used. Thanks to our modelling and its similarities with the models used in optical design, we present planar multilayers that enable to shape their thermal radiation. These structures, based on the concept of zero admittance layer (ZAL), concentrate their thermal radiation in a very small spectral or angular bandwidth. They are an interesting alternative to 2D structures such as gratings or meta-surfaces, or to photonic crystals.

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