Research Article Vol. 25, No. 12 | 12 Jun 2017 | OPTICS EXPRESS A589

Optics EXPRESS

Evaluation of blackbody radiation emitted by arbitrarily shaped bodies using the source model technique

ILYA SISTER,* YEHUDA LEVIATAN, AND LEVI SCHÄCHTER

Electrical Engineering Department, Technion–IIT, Haifa 32000, Israel
**ilyasister@hotmail.com*

Abstract: Planck's famous blackbody radiation law was derived under the assumption that the dimensions of the radiating body are significantly larger than the radiated wavelengths. What is unique about Planck's formula is the fact that it is independent of the exact loss mechanism and the geometry. Therefore, for a long period of time, it was regarded as a fundamental property of all materials. Deviations from its predictions were attributed to imperfections and referred to as the emissivity of the specific body, a quantity which was always assumed to be smaller than unity. Recent studies showed that the emission spectrum is affected by the geometry of the body and in fact, in a limited frequency range, the emitted spectrum may exceed Planck's prediction provided the typical size of the body is of the same order of magnitude as the emitted wavelength. For the investigation of the blackbody radiation from an arbitrarily shaped body, we developed a code which incorporates the fluctuation-dissipation theorem (FDT) and the source model technique (SMT). The former determines the correlation between the quasi-microscopic current densities in the body and the latter is used to solve the electromagnetic problem numerically. In this study we present the essence of combining the two concepts. We verify the validity of our code by comparing its results obtained for the case of a sphere against analytic results and discuss how the accuracy of the solution is assessed in the general case. Finally, we illustrate several configurations in which the emitted spectrum exceeds Planck's prediction as well as cases in which the geometrical resonances of the body are revealed.

OCIS codes: (290.6815) Thermal emission; (350.5610) Radiation; (050.6624) Subwavelength structures; (000.4430) Numerical approximation and analysis.