Comment

Comment on "Surface temperature measurement of dielectric materials heated by pulsed laser radiation"

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Recently, Zenobi, Hahn and Zare introduced thin-film resistance sensors for the surface temperature measurement of dielectric materials heated by pulsed laser radiation. They concluded that absorption or reflection by their thin-film sensor is in any case negligible, thus causing no systematic errors. We show theoretically and experimentally that the thin-film sensors can be very effective absorbers for the infrared radiation used by Zenobi et al. The absorptance of the thin-film sensor is negligible only if its square resistance is greater than 10 kΩ.

1. Introduction

In a recent paper [1], Zenobi, Hahn and Zare introduced a new method to measure the transient surface temperature induced by pulsed laser irradiation. The key of the method is an "optically thin" metal stripe which is used as a resistivity thermometer for measuring transient surface temperatures with a nanosecond time resolution.

The necessary condition for the application of the method to any insulator surface is that the sensor is "optically thin" or, equivalently, that the sensor does not change the absorption or reflection properties of the insulator. Zenobi et al. argue that: "Compared with the wavelength of the laser (10.6 μm) the sensor is 1000 times thinner and should therefore be nearly transparent to the infrared radiation, i.e. should not absorb or reflect it". They further conclude that: "Similarly, IR reflectivities of the surfaces are independent of the presence or absence of a thin Pt film within experimental error".

The aim of this comment is a critical discussion of these arguments. It is shown both theoretically and experimentally that the thin-film resistance sensors can be very effective absorbers for the infrared radiation which was used by Zenobi et al. Only with an appropriate design of the sensor, e.g. a sensor which has a high electrical resistance, will no measurable influence on the optical properties of the investigated surface occur.

2. Absorptance of thin-film resistance sensors

2.1. Absorptance of a thin continuous metal film

The optical system discussed is shown schematically in fig. 1. It consists of two dielectric materials with refractive indices $\bar{n}_1$, $\bar{n}_2$ separated by a thin metal

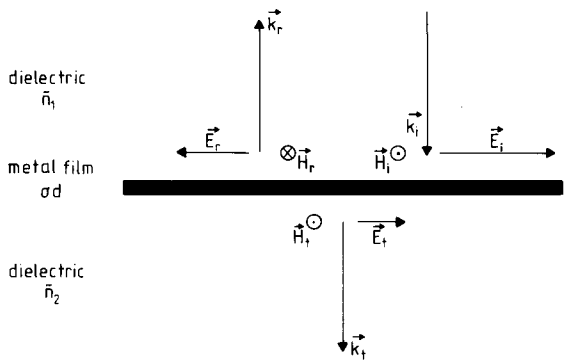

Fig. 1. Incident, transmitted and reflected electric and magnetic fields at an interface between two dielectric materials with indices of refraction $\bar{n}_1$ and $\bar{n}_2$ and a thin metal sheet of conductivity σ and thickness d.