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Easy measurement of the thermal conductivity of coatings with the TDTR method

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Functional coatings and thin films are applied for many purposes: To yield effects such as increased wear resistance and corrosion protection, to achieve certain sensing or optical properties and many more. Generally, it can be said that thermal properties of materials gain importance in many fields, ranging from electronics to wear protection. Indeed, an important aspect of coatings is their thermal conductivity which plays a crucial role in many applications.
However, suitable values for the thermal conductivity often cannot be taken from literature since the thermal conductivity is strongly dependent on the crystalline film structure and, mostly, only values for bulk material are given for very specific compositions. This is why special measurement methods are required for characterizing thin films.
Here, the method of time-domain thermoreflectance (TDTR) provides an efficient means of measuring the thermal conductivity of coatings with layer thicknesses spanning the entire common thickness range from single nanometers to several millimeters. The method is straightforward and only requires a minimum of easy sample preparation.
In this talk, the basics of heat conduction and the working principle of the TDTR method will be explained. It is generally found that the nano- and microstructure and atomic composition of a film strongly influence thermal conductivity. Application examples will be shown for the field of hard coatings for wear and corrosion protection, thermoelectrics and sensor technology. Of course, the measurement method is not limited to these fields but can, in principle, be applied to all kinds of coatings. The results are not only interesting with regard to applications, but also in respect of to heat conduction science, which is a subtopic of solid state physics.

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