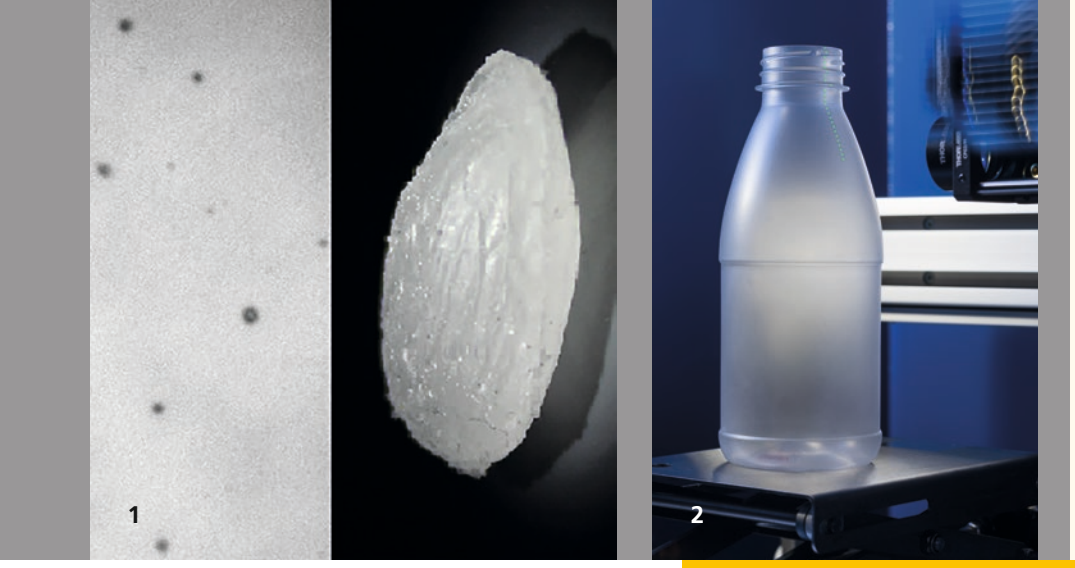

MULTIDIMENSIONAL DOSIMETRY FOR PROCESS CONTROL IN ELECTRON BEAM IRRADIATION

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Electron beam irradiation is an important health- and security-related technology, which is required in many fields, such as surface sterilization, vaccine production or the definition of material properties in radiation processing. Dosimetry ensures the assessment of the ionizing radiation dose absorbed, quality assurance and process control. Dosimeters come in the form of tailored polymer stripes or pellets as carriers of a radiation-sensitive material, which are analyzed in laboratory devices. But state-of-the-art dosimetry systems cannot determine doses on complex product surfaces (3D), in points (1D) or as depth dose profiles (2D) inside a product. Nor are they suitable for in-line process control.

Dosimetry in 1D, 2D and 3D

To eliminate these drawbacks, Fraunhofer IKTS, together with international partners, developed a multidimensionally applicable dosimetry system based on a radiation-sensitive ceramic phosphor in the Eurostars project "READ". Upon excitation with a near-infrared light pulse, the material shows luminescence, the decay time of which is dependent on the dose of electron beam irradiation. Thus, the optical read-out of the luminescence decay time makes it possible to determine the inserted radiation dose in the range of 0.1 to 30 kGy.

As the ceramic phosphor is provided in powder form, various deposition techniques are possible: The µm-sized phosphors can be embedded into other materials, giving access to dose information inside the products, at each spatial position of a particle, along a line (e.g. depth dose profile) or within a cross-sectional area, respectively.

New fields of application

The possible preparation of dosimetrically active polymeric twin products (Figure 1) is particularly interesting. By retaining the radiation penetration properties of the original product, it is possible to conduct dosimetry of bulk dry goods, such as seeds. Another option is the chemical attachment of the phosphor particles to fibers. When these are interwoven to meshes for medical scaffolds, it becomes possible to monitor the sterilization process of the scaffolds. The phosphor powder can also be integrated into polymer matrices to formulate inks and lacquers, which allows the labeling of specific surface areas or coating of entire 3D product surfaces prior to radiation exposure (Figure 2) and thus, 2D or 3D dose maps are obtained thereafter (Figure 3).

The user obtains test product bodies equaling the original product's geometry and properties but equipped with dosimetric functionality. These test products then undergo the radiation exposure during installation qualification, process qualification or for routine process quality assessment. They provide automated in-line read-outs with an unprecedented spatial dose resolution.

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1 Embedded phosphor particles (right) in a polymeric twin almond (left).
2 Optical dose read-out of a phosphor-coated 3D surface.
3 Resulting 3D dose map.

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