Today we are convinced that there are numerous applications for this new analytical tool, especially when controls have to be performed on rare, high-cost, or infectious material for which a nonintrusive remote technique is compulsory or that repetitive measurements need to be done on the same sample over prolonged periods.

Low-Temperature Thermoluminescence of Dry Material

Thermo luminescence analysis has been applied to solids for quite a long time in archeological research and radiation dosimetry. In both cases the samples that have been activated by natural and/or man-made radiation sources present a certain number of energy traps that can be emptied by heating. For the datation of ceramics, the heating cycle is extremely fast and brings the sample to more than 300°C in less than a couple of minutes. The magnitude of the light emission under well-standardized conditions is directly linked to the age of the material, which can be determined over several centuries with an accuracy of a few percentage points.

For radiation dosimetry, within or around nuclear plants as well as in open green fields and in the environment at large, the analysts make use, generally, of so-called thermoluminescent solids that are susceptible to "activation" over a large span of doses. Espagnan et al. developed a refined method to that end using lithium fluoride tablets, which are first totally deactivated at 400°C and then exposed to the radiation field at ambient temperature. Reading is done by recording the emission peaks during their progressive "extraction" in the course of a constant-speed (1°C/sec) heating, which generally shows up between 200°C and 400°C.

At the onset of our research work, we tried to operate in the same way with freeze-dried products that had received a strong γ-irradiation (40–60 kGy) at room temperature. The results were disappointing because we were limited to rather low temperatures (below 100°C) and, even so, when the material could stand high temperatures like freeze-dried silica. This is why we attempted to apply to these products the same methodology that we used previously for our investigation on water and solutions.

The dry samples are irradiated at −196°C and deactivated by a gentle rewarming (1.5°C/min) to room temperature. Our preliminary results look promising (Fig. 19).

Figure 20, for instance, shows the behavior of a freeze-dried plug of mannitol (residual moisture 1.5%). We can see that, in comparison with the initial solution (at 10% mannitol), the thermoluminescence of the dry material is some 20 times stronger and does not follow the same pattern. The lower peak (at −152°C) is very narrow whereas the higher one (near −118°C) is substantially depressed. This is not surprising if we assume that the first peak is directly connected to the water molecule itself while the second one seems to be geared to the three-dimensional network of the water molecules within the crystalline lattice.

Additional studies done on freeze-dried silica gels (microbeads gels from Rhodia, Salindres) give some support to this idea. In Figure 21, for instance, we can see that when we shift from a largely hydrated material (like the fresh starting material at around 40% residual moisture) to the low residual moisture