particle, and the two-dimensional image that is formed is stored in a computer system. This detector enables the detection of 2.0 dpm/min on the chromatogram, whereas a quantitative measurement in the range of 5–50 dpm is possible for ^{14}C-labeled compounds.

In the improved version of this device (β-Imager 2000), the counting gas was replaced by a mixture of argon containing triethylamine (37). The maximum field of view is 20 × 25 cm, thus enabling the imaging of an entire standard TLC plate. The full field-of-view resolution for ^{3}H is 200 μm, whereas for ^{14}C, ^{35}S, and ^{33}P it is 350 μm. This value is 500 μm for ^{32}P. (In maximum zoom position, where the field of view is 25 × 33 mm, resolution values are considerably reduced, e.g., 50 μm for ^{3}H.) These data demonstrate that by using this instrument, resolution comparable to that of a film or phosphor imager can be obtained. According to the manufacturer, the detection threshold for ^{3}H amounts to 0.007 cpm/mm^2 (cpm = count per minute), whereas it is 0.01 cpm/mm^2 for ^{35}S, ^{14}C, and ^{33}P and 0.1 cpm/mm^2 for ^{32}P. Counting response is linear over a range of 10^4.

C. Storage Phosphor Screen Imaging

1. Principle and Technology

Storage phosphor screen imaging technology was introduced by Fuji Photo Film Company in the 1980s, and now these types of instruments are also supplied by other companies (e.g., Molecular Dynamics, Biorad, and Packard). From a practical point of view, the procedure carried out with the phosphor image technique is very similar to that of film autoradiography, and it is sometimes termed "filmless autoradiography." Screens are sensitive to any source of ionizing radiation; therefore, commonly used isotopes such as ^{14}C, ^{3}H, ^{35}S, ^{125}I, ^{32}P, and ^{33}P can be detected.

The phosphor screen is the crucial part of this technology. It is a flexible image sensor in which bunches of crystals (the grain size is about 5 μm) of a photostimulable phosphor of barium fluorobromide are uniformly coated on a support film. The BaFX:Eu^{2+} (X = Cl, Br, or I) crystal is an ionic crystal having a tetragonal structure, and Ba is replaced with the Eu^{2+} ion to create a solid solution. This crystal, when irradiated, stores the energy in the crystal vacancies. The luminescence mechanism of this photostimulable phosphor is interpreted as follows. When the exposed Eu^{2+} ions become Eu^{3+} ions through primary excitation by X-rays, for example, electrons are released into the conduction band. These electrons are trapped in the Br vacancies, which are inherently present in the crystal, and color centers of the metastable state are formed. During reading, as a result of the use of red laser light (at 633 nm), trapped electrons are liberated again into the conduction band of the crystals. In this manner, Eu^{3+} ions are converted back to Eu^{2+} ions while releasing photons of blue light at 390 nm (38). The process is schematically shown in Fig. 2. It should be noted that another formulation of the phosphor screen has also been developed

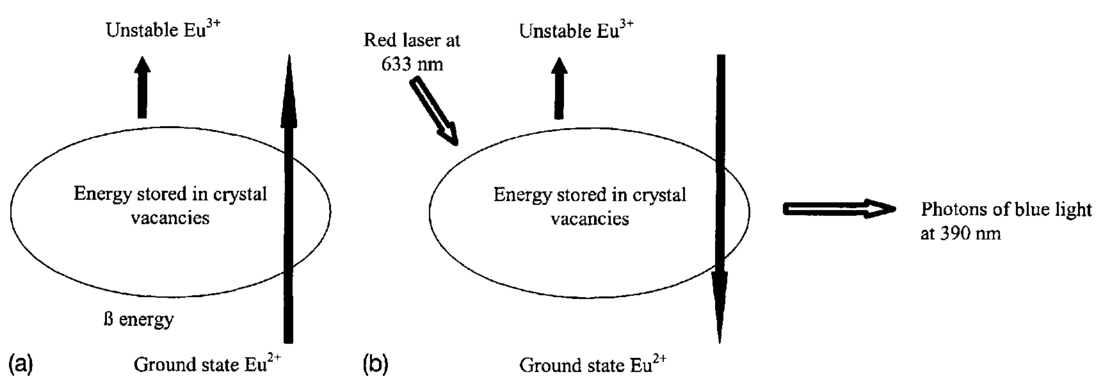

Figure 2 A schematic representation of the phosphor image mechanism. (a) Exposure, (b) scanning.