

## Self-indicating Instant Radiation Alert Dosimeter (SIRAD)

SIRADs are user-friendly, low-cost, wearable, and disposable radiation dosimeters for monitoring high dose (2 to 1,000 rads) of ionizing radiation. As the name suggests, they are self-indicating and instant radiation dosimeters. They are always active and ready to use. They don't need battery. Photos of SIRAD badges before and after irradiation with 40 rads of 100 KVP X-ray of a 2-200 rads (the first generation SIRAD) badge are shown in Figure 1.

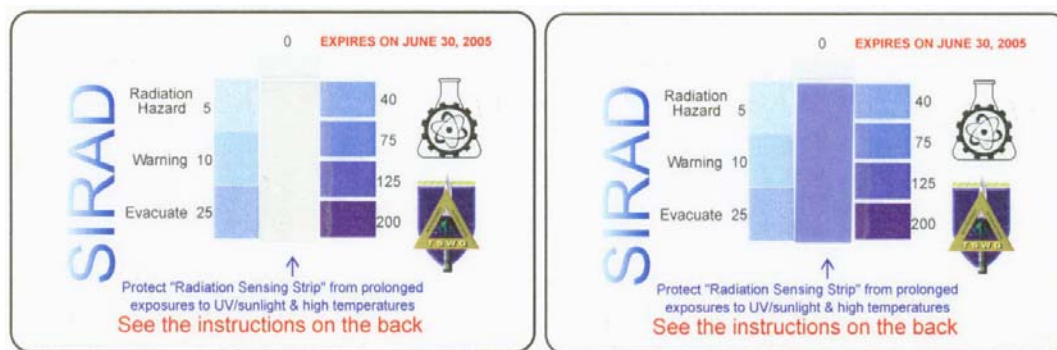


Figure 1: Photos of SIRAD badges before (left) and after (right) irradiation with 100 rads of 100 KVP X-ray (batch #0406). The color bars printed with dose-number on each side of the sensor is referred to as color reference chart. This first generation SIRAD was used for field testing the technology by the US Department of Homeland Security with 800 first responders in the states of NJ, NY and IL, <http://www.eml.st.dhs.gov/publications/reports/EML627.pdf>. **This dosimeter is no longer available. However, the sensor materials for all dosimeters of today are essentially similar in nature.**

### SENSOR - HOW DOES IT WORK?

When exposed to radiation from a dirty bomb, nuclear detonation or a radiation source, the sensor of SIRAD develops a blue color instantly (e.g., see Figure 1). The color intensifies as the dose increases (see Figure 2 for photos of a series of sensors exposed to different dosages of X-ray), providing the wearer and medical personnel instantaneous information on cumulative radiation exposure of the victim.



Figure 2: A series of photos of portions of the sensors irradiated with different dosages (rads) of 100 KVP X-ray (batch #0406).

The color intensity of the sensor increases with increasing dose. A plot of the sensor's optical density (OD) (batch #0406) versus dose is shown in Figure 3. Dose can be estimated with an accuracy of about

10% by determining optical density of the sensor using the plot of Figure 3. **Note:** The data provided on this page (e.g., Figures 2 and 3) are applicable only for the dosimeter shown in Figure 1 (batch 0406). Other batches of dosimeters may have different properties and hence the data of Figures 2 and 3 can't be used for estimation of dose for the dosimeters from other batches.

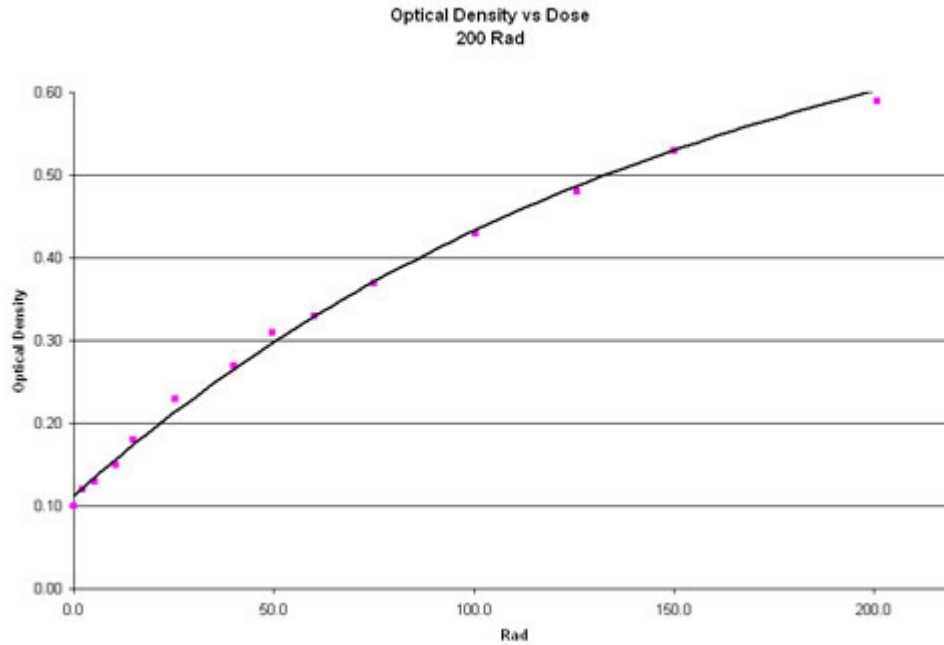


Figure 3. A plot of optical density versus dose (batch #0406).

Visible spectra of the element irradiated with different dosages are shown in Figure 4.

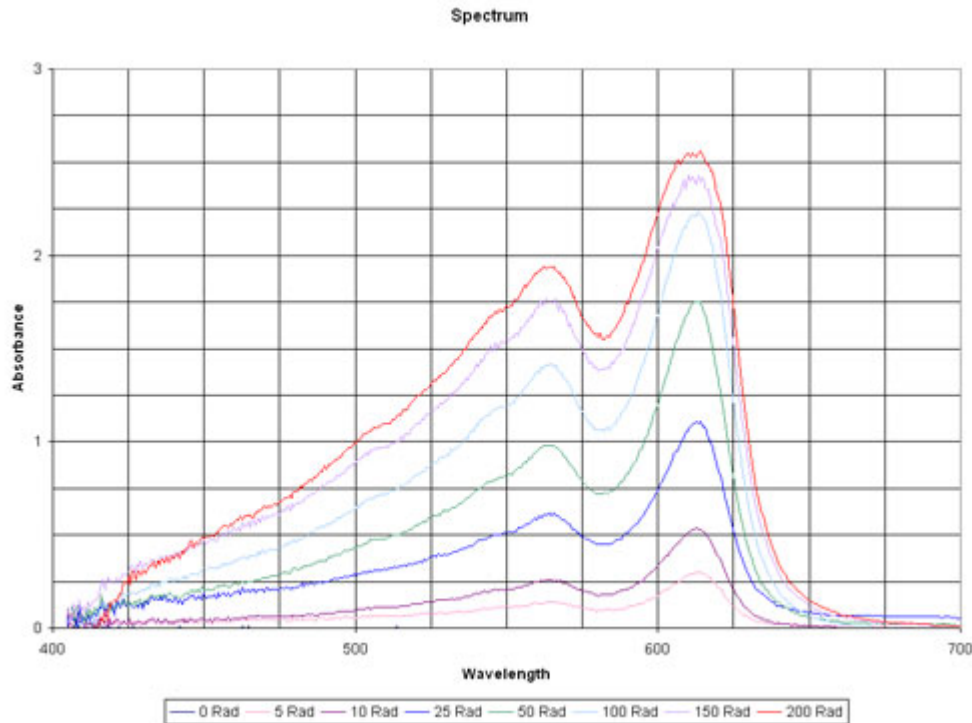


Figure 4. Visible spectra of element irradiated with different dosages of 10 MVP X-ray.

**Sensing Materials:** Materials used in the dosimeter's radiation sensor are a unique class of compounds called diacetylenes ( $R-C\equiv C-C\equiv C-R$ , where R is a substituent group). Diacetylenes are colorless solid monomers. They usually form red or blue-colored polymers/plastics,  $[(R)C\equiv C-C\equiv C(R)]_n$ , when irradiated with high energy radiations, such as X-ray, gamma ray and electrons. As the exposure to radiation increases, the color of the sensor made from diacetylenes intensifies proportional to the dose. One can estimate the dose by comparing the color of the sensor with one of the bars of the color reference chart printed on each side of the sensor.

#### **TYPES OF RADIATION SIRAD WILL MONITOR**

The unprotected sensor of SIRAD is sensitive to all kinds of radiation having energy higher than about 10 eV (wavelength shorter than visible light). It can potentially monitor all kinds of X-ray (e.g., 10 KeV and higher), electrons, protons and alpha particles and neutrons. Since the sensor is covered with a UV absorbing film, any high LET particles, such as low energy electrons, protons, alpha, meson, pion and heavy ions, will get absorbed by the protective film and may not reach the sensor. However, electrons and protons having megavolt energy will be able to penetrate the protective film and can be monitored by the sensor.