Physics Education

RADIATION

Cheap educational materials for understanding radiation

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On 11 March 2011, a large earthquake and tsunami caused serious damage to the Fukushima nuclear power plants, releasing a huge quantity of radionuclides into the surrounding environment. Specialists are not the only people who need to know about radiation; students also have an urgent need to be educated about radiation to protect themselves. Because radiation is not evident to the senses, various types of sensors are used to detect it [1]. However, these are prohibitively expensive for schools.

Recently, we demonstrated that radiation can be detected by its effect on common plastics [2]. This result led us to develop a cheap teaching resource for radiation education based on the familiar plastic drink bottle. Polyethylene terephthalate (PET), which is the main component of plastic bottles, emits ultraviolet light (380 nm wavelength) when exposed to radiation [3]. We used this characteristic of the plastic to design an easy experimental setup (shown in figure 1) to sense radiation by using material from plastic bottles as scintillators. Two photon sensors are attached to the side of a box with a reflective inner surface. One side of the box, made of clear acrylic board, serves as a sample stand. A small fragment of a plastic bottle is placed on the acrylic board. In our experiments, a ^{36}Cl radiation source was placed on the plastic fragment to evaluate its sensitivity as a radiation sensor.

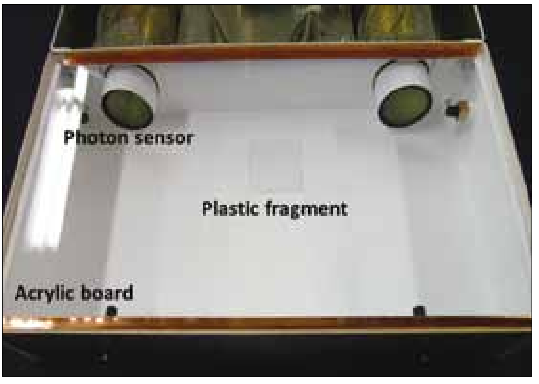

Figure 1. *The experimental setup. The box is 250 × 130 × 50 mm. At the far side are two photomultiplier tubes used as photon sensors. A photodiode or other sensor can alternatively be used instead of a photomultiplier tube. In the middle of the clear acrylic face of the box is a fragment of a plastic bottle measuring about 25 × 25 mm.*

Plastic bottles are used all over the world in a wide range of formulations. We investigated 36 kinds of plastic bottles commonly sold in Japan by using beta particles from a ^{36}Cl radiation source.

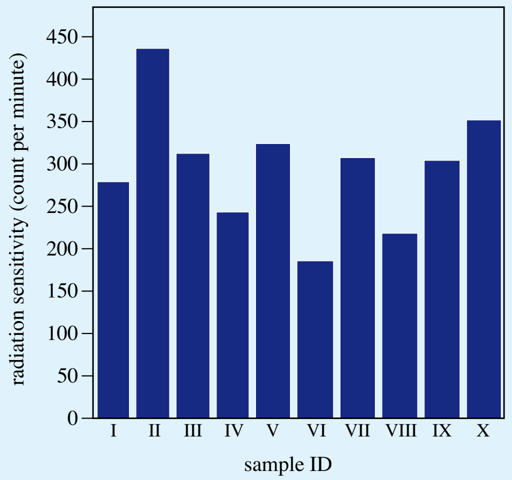

Figure 2. *Photon counts detected from irradiation of 10 different plastic samples.*

Figure 2 shows a wide range in detection sensitivity among 10 kinds of plastic bottles (table 1), which made good experimental materials because they were especially flexible and easy to cut. It appears to be easy to find bottles with widely differing detection sensitivities, even within the product range of a single bottle (see V–VIII in figure 2). This result demonstrates that familiar plastic bottles can be used as a cheap teaching resource for rough measurements of radiation. It is also important to determine how this difference scales with impurity concentrations in plastic bottles.

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Table 1. Plastic bottle types

ID	*Company*
I	Asahi
II	Ito En
III	Ito En
IV	Otsuka Pharmaceutical
V	Coca Cola
VI	Coca Cola
VII	Coca Cola
VIII	Coca Cola
IX	Suntory
X	Suntory

References
[1] Knoll G F 1998 *Radiation Detection and Measurement* 3rd edn (New York: Wiley)
[2] Nakamura H *et al* 2011 *Europhys. Lett.* **95** 22001
[3] Nakamura H *et al* 2010 *Proc. R. Soc.* A **466** 2847

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