Case Study: Raman Spectroscope in an open Lab

A lab purchased a Mettler-Toledo ReactRaman 785, an in-situ Raman spectroscope, to monitor crystallization processes and reveal reaction mechanisms. The instrument is a Class 3B laser system with a 475mW, 785nm diode laser.

Figure 1: Probe on Lab Stand

The system has a transmitter/receiver probe at the end of a fiber-optic cable which can be mounted in a variety of configurations, including immersion into a free-standing beaker of liquid. The proposed use was to mount the ball probe on a lab stand as shown in Figure 1. The tip of the probe with the cover removed would be immersed in a 30ml beaker of biological sample and then covered in aluminum foil to minimize light intrusion.

This design had a number of challenges:

1. The manufacturer indicated in the user manual that laser protective eyewear with an optical density of 6+ at 785nm was necessary.
2. User noted that covering the beaker with aluminum foil did not provide adequate light isolation. Because of this, the experimenters were turning off the room light during the experiment. In a darkened room, the dark laser protective eyewear as specified by the vendor (visible light transmission of only 37%) made it very difficult to see and operate safely in the physically crowded lab.
3. The Nominal Hazard Zone (NHZ) for this configuration was calculated to be over ½ meter from the probe head and over 2.5 meters as a free air beam. This would have required the entire lab to be equipped with laser protections such as eyewear. Because the lab was general access, laser protective eyewear would probably have been required for at least 20 people, at $100+ each.

Solution:

A small Laser Control Area surrounding the Raman spectroscope probe was designed, protecting the lab users from unsafe levels of laser energy and completely eliminate ambient light from the test cell. A small EPDM rubber cap was adapted to serve as a laser barrier (Figure 2), fitting over the beaker and allowing the probe to penetrate through a small hole

without light leakage (Figure 3). Use of this protective cap was added to the experimental protocols of the lab, and the laser warning signage was updated to instruct users to install the cap before activating the laser (Figure 4).

Figure 2: Tube and beaker sitting on either side of Spectroscope probe

Figure 3: Shroud with probe inserted to working depth

Figure 4: Laser Control Area Sign for Lab

Costs / Savings:

The production of four enclosures designed for the 30ml beakers was less than $175.00.

Materials:

1. EPDM Round top caps, 2" ID, McMaster-Carr 6448K112, approximately $2.00 each.
2. PVC Round caps, 2"ID, McMaster-Carr 400005K51, approximately $1.65 each.
3. Polypropylene Tubes, 2" OD x 1.5" ID x 3" long, (McMaster-Carr 1859T23) $13.45/foot.

Labor – To cut the tube to 3" lengths and relieve for the beaker spout - $27.00 each

Since the laser is limited to a small area, use of the Raman spectroscope no longer interferes with safe use of the remainder of the lab, increasing experimental throughput. About $2,000 in costs for laser protective eyewear were avoided.