# The Best of Both Worlds: Hybrid Enclosures for Radioactive Collection Materials

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## Introduction to Uranium in Ceramic Objects

From the 1830s through the 1940s, uranium was a common colorant for ceramic glazes and glass objects. Some commercial products, including the popular Fiesta® brand tableware, even continued to be made with uranium into the 1970s. As a component in ceramic glazes, uranium was used to achieve a range of colors—from yellow-green, orange, and red, to ivory, gray, and black—and was also desirable for its opacifying qualities. The popularity of the vibrant colors enabled by uranium made its use in ceramic objects a global phenomenon. As a result, these materials are frequently represented in museums with design collections featuring materials from the 19th and 20th centuries. Radioactive objects can also be found in museum collection materials as disparate as navigational dials, clocks, compasses, and fossils or mineral specimens.

Ceramics with uranium glazes in The Metropolitan Museum of Art's Department of Modern and Contemporary Art (*fig. 1 & 2*) were identified using long wave ultraviolet light (UVA), a Geiger counter, and X-ray fluorescence spectroscopy (XRF). Under UV light, some uranium glazes exhibit the same well-known green fluorescence as uranium glass (*figure 2*), but this technique cannot be considered diagnostic because of the many potential causes of the effect. Furthermore, interference from other components in the glaze matrix can keep some uranium glazes from fluorescing. Following examination with UV light, Geiger counter readings demonstrated the radioactivity of the glazes, and finally the presence of uranium was confirmed with pXRF.


*Fig. 1:* Examples of uranium glaze ceramics at The Met in the Department of Modern and Contemporary Art.

## Risks Posed by Uranium Glaze Ceramics

Objects containing uranium emit alpha, beta, and gamma radiation. While alpha and beta radiation have the greatest ability to damage living tissue, gamma radiation exposure is generally considered more concerning to those working with uranium-containing ceramics because alpha and beta particles are unable to travel far from their sources and can be blocked by relatively light materials. Studies have found the risks of handling uranium-containing ceramics to be minimal when reasonable precautions are taken. However, in the event of damage to an object, prolonged close contact with fragments caught in the folds of clothing or a particle inhaled into the lungs could have serious health effects through direct exposure to alpha and beta radiation. In addition to these risks, uranium also generates radon gas as it decays. Radon is carcinogenic and the second leading cause of lung cancer in the United States, after smoking.

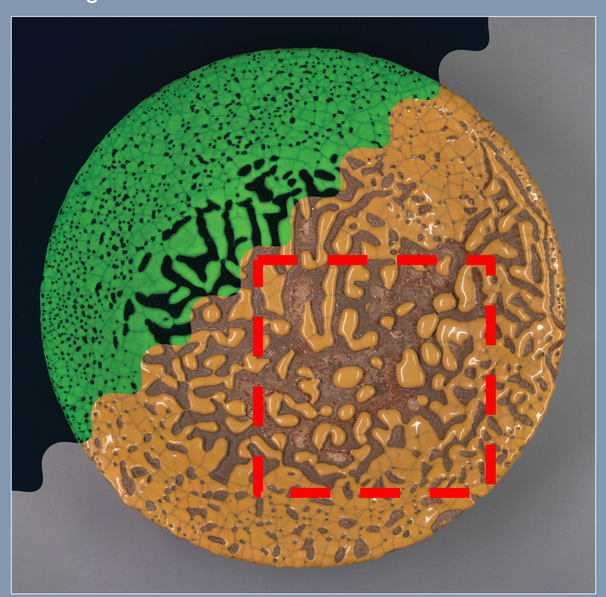

*Fig. 2:* Fluorescence of uranium glaze under UV. *Bowl*, Glen Lukens (H 3"; D 14-3/4").
Gift of Florene M. Schoenborn, 1987 (1987.469.5)

*Fig. 3:* Detail of uranium glaze losses. *Bowl*, Glen Lukens (H 3"; D 14-3/4") MMA1987.469.5

Institutions concerned with the containment of particles shed by radioactive objects have come to diverging solutions. Sealing objects in zip-top bags effectively prevents particulate contamination but also traps radon gas generated by the objects, necessitating opening the bags in a ventilated space. While radon has a half life of 3.8 days, it is continuously generated by uranium, and even exposure to small amounts poses safety concerns. Furthermore, the decay products of radon (such as polonium-218 and lead-210) are solids with their own safety risks. Housing radioactive objects in open trays prevents the buildup of radon and its decay products but may not fully contain fragments should the object be damaged. A solution was needed that could address both problems for safer handling and storage.

### Existing Approaches to Storing Radioactive Objects

**Open Tray**
- ✔ Vents radon gas
- ✘ May allow fragments to escape

**Sealed Bag**
- ✔ Fully contains fragments
- ✘ Traps radon gas

## Novel Enclosures for Uranium Glaze Ceramics

Hybrid enclosures—half polyethylene (PE) zip top bag, half soft Tyvek® (spunbonded PE)—were devised to contain fragments that could detach from the uranium glaze ceramics while also preventing the accumulation of radon gas. By design, Tyvek® is gas permeable and is widely used in construction as a building wrap as it transmits both radon and moisture. It is also used in the medical device industry to sterilize sealed surgical instruments by exposure to ethylene oxide gas or steam. As materials, PE zip top bags and soft Tyvek® are compatible and complementary.

| Polyethylene Zip Top Bags | Tyvek® (Grade 14-M) | Hybrid Enclosure |
|---|---|---|
| • allow visibility of object within<br>• zip closure system is re-sealable | • allows nearly 100% radon transmission<br>• easily joined to pieces of PE bags with a heat sealer | ✔ Fully contains fragments<br>✔ Vents radon gas |

A CoLibri Library Cover System, an impulse heat sealer frequently used in library conservation labs to create custom book covers, was used to join pieces of PE zip top bags and soft Tyvek® to construct the hybrid enclosures (*fig. 4*). The enclosures are customizable to any object. These hybrid enclosures have not been proposed for use with uranium glass objects because they contain less uranium than ceramic glazes and are also less likely to have friable surfaces.

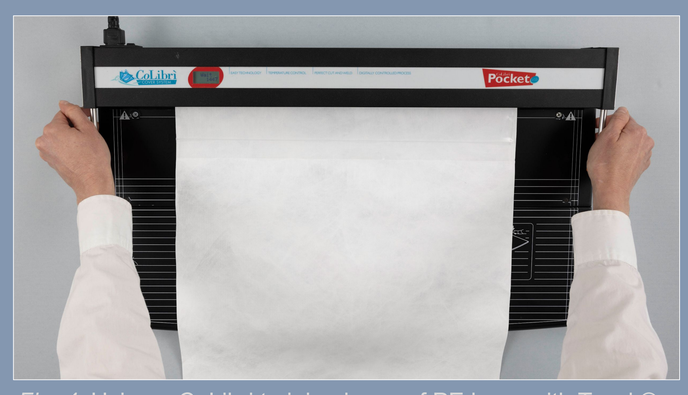


*Fig. 4:* Using a CoLibri to join pieces of PE bags with Tyvek®

*Fig. 5: Finished hybrid enclosure*

## MAKE YOUR OWN:

Scan the QR code for step-by-step instructions on making your own enclosures!

## Future Research

Hybrid PE/Tyvek® enclosures could have other applications beyond containing radioactive objects: the enclosures have the potential to be used in any situation where the creation of a microclimate in a sealed bag is undesirable by providing containment while maintaining breathability and visibility.

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## References

Ashton, John. 1993. "Radiation Hazards in Museum Aircraft." In *Saving the Twentieth Century: The Conservation of Modern Materials*, edited by David Grattan, 287-300. Ottawa: Canadian Conservation Institute.
Golinski, Thomas, "Effect of Tyvek Porosity Rates on Burst Testing of Flexible Medical Device Pouches" (2002). Thesis. Rochester Institute of Technology. Accessed from https://repository.rit.edu/theses
Kotrappa, Paul, Lorin Stieff, and Frederick Stieff. "Attenuation of Thoron (Rn220) in TYVEK® Membranes." AARST Proceedings, 2014.
Norquest, Emily, Amelia Kile, and David Peters. 2015. "Working with a Collection of Radioactive Aircraft Instruments." *Objects Specialty Group Postprints 2015* Vol. 22 (2015): 169-180. Washington, DC: American Institute for Conservation of Historic & Artistic Works.
Rowe, Sophie. 2018. "Managing Small Radioactive Collections in the UK: Experiences from the Polar Museum, Cambridge." *Journal of Conservation and Museum Studies* 16(1): 1-14. https://doi.org/10.5334/jcms.166.
Spitz, Henry, and David Sliney. 2011. "Ionizing Radiation and Lasers." In *Health & Safety for Museum Professionals*, edited by Catharine Hawks et al., 455-484. New York: Society for the Preservation of Natural History Collections.
Stieff, Alexandra, Paul Kotrappa, and Frederick Stieff. 2012. "The Use of Barrier Bags with Radon Detectors." *American Association of Radon Scientists and Technologists Proceedings 2012*. 67-79. https://aarst.org/proceedings/2012/04_THE_USE_OF_BARRIER_BAGS_WITH_RADON_DETECTORS.pdf.
Strahan, Donna. 2001. "Uranium in Glass, Glazes and Enamels: History, Identification and Handling." *Studies in Conservation* Vol. 46, No. 3 (2001): 181-195. https://www.jstor.org/stable/1506809.
US Nuclear Regulatory Commission. 2001. "Glazed Ceramic Tableware." In *Systematic Radiological Assessment of Exemptions for Source and Byproduct Materials*, prepared by S. Schneider et al., 191-208. Washington, DC: US Nuclear Regulatory Commission.