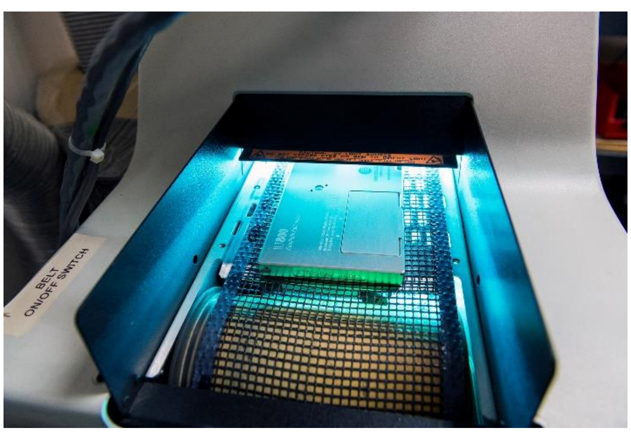
Ultraviolet (UV) radiation in curing operations

The most obvious source of UV radiation is the sun. But UV radiation is also found in artificial sources, such as fluorescent and incandescent lamps, and is generated during welding. An unrecognized hazard comes from a process introduced in the 1960s: UV curing.

UV curing uses high-intensity UV light to initiate a photochemical reaction that instantly cures inks, adhesives, and coatings. The process is used for applications in automotive and aerospace assembly, electronics, medical device assembly, manufacturing, and 3D printing, on materials such as plastic, glass, wood, metal, etc.

UV curing systems use a variety of light sources, such as mercury vapor lamps, fluorescent lamps, and light-emitting diodes (LEDs). Sources that emit UV radiation at wavelengths below 250 nm may emit ozone into the air.

Systems can be as small as spot hand-held curing systems for compact products or large cabinets with conveyors for mass production.



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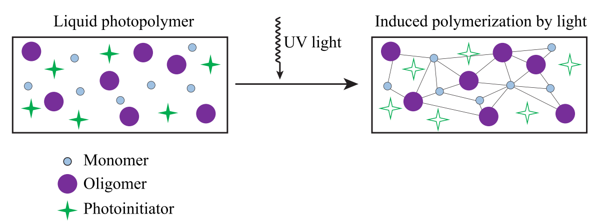
https://www.intl-lighttech.com/

To evaluate UV curing products, read the label and review the safety data sheets (SDSs). In Section 3 of the SDS, Composition/-information on ingredients, you may see "photoinitiator" listed under hazardous components.

Photoinitiators initiate a process known as polymerization. Radical polymerization uses acrylates, while cationic polymerization uses epoxy resins. The polymer chains cross-link together to form a strong structure, as the material changes from a liquid to a solid.



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The chemicals may have a "Warning" or "Danger" signal word. Look for the following hazard statements and pictograms to assess the chemical hazards associated with the UV curing process:

- Causes skin irritation
- May cause an allergic skin reaction
- May cause sensitization by skin contact
- Causes severe skin burns
- Causes serious eye damage

What are the hazards?

UV radiation can't be seen and is not felt immediately but can cause adverse short and long-term health effects to the eyes and skin.

The user may not realize the danger until after the exposure has caused damage. Symptoms can occur four to 24 hours after exposure.

Acute skin effects appear within a few hours of exposure, while chronic effects are long-lasting and cumulative and may not appear for years. An acute effect of UV radiation is redness of the skin called erythema (similar to sunburn). Chronic effects include accelerated skin aging and skin cancer. UV radiation may cause photosensitization.

UV radiation is absorbed in the outer layers of the eye—the cornea and conjunctiva. Acute overexposure causes a painful temporary inflammation of the cornea, known as photokeratitis (welder's flash), or photoconjunctivitis. Repeat UV overexposure to the eyes is unlikely because of the pain involved. Symptoms include sensation of sand in the eyes, blurred vision, tearing, light sensitivity, and uncontrolled blinking. Chronic exposure leads to an increased risk of certain types of ocular cataracts.

How much is too much?

There are no Oregon OSHA Permissible Exposure Limits for UV radiation.

The American Conference of Governmental Industrial Hygienists (ACGIH®) has established threshold limit values (TLVs®) for UV radiation. Depending on exposure duration, the allowable effective irradiance ranges from 0.0001 milliwatt per square centimeter (mW/cm^2) for eight hours to 30 mW/cm^2 for 0.1 second.

The TLVs® don't apply to exposures to photosensitive individuals, normal individuals concurrently exposed to photosensitizing agents, or people who have undergone cataract surgery. Photosensitizers include certain plants and chemicals such as some antibiotics and antidepressants, diuretics, cosmetics, antipsychotic drugs, coal tar distillates, some dyes, and lime oil. There is no safe lower threshold for chronic effects such as skin cancer.

UV levels can be measured for comparison to threshold limit values using special radiometers or spectrophotometers.

How can exposures be minimized?

1. **Engineering controls**
   a. Use interlocks to prevent UV source from operating if system is open.
   b. Enclose system to block reflected or visible light from UV lamps on skin or eyes. Use anodized metal or transparent UV-blocking plastic for shielding.
   c. Include local exhaust ventilation for systems with lamps that produce ozone.
   d. Establish preventative maintenance program for UV curing systems.
2. **Administrative controls**
   a. Provide training on UV hazards.
   b. Limit access to staff who are aware of and protected from UV hazards.
   c. Minimize duration of work to maintain exposures below threshold levels.
   d. Install hazard warning signs.
   e. Follow stringent hygiene practices to ensure that no photoreactive chemical remains on unprotected skin.
3. **Personal Protective Equipment**
   a. Require eyewear that is compliant with ANSI Z87.1 (UV filter marking **U**, followed by a number on a scale of 2 to 6).
   b. Provide UV-absorbing face shield.
   c. Wear nitrile, latex, or tightly woven fabric gloves that overlap the sleeves of protective clothing. Check for compatibility of protection against chemical exposures.
   d. Wear clothing that fastens securely at the wrists and up the neck, with knitted cuffs at the wrist and neck, so that no skin is exposed. Tyvek® does not protect against UV.
   e. Use sunscreen with SPF 15 or higher on skin that can't be covered by clothing and as back-up for PPE.

Resources

1. ACGIH® *Documentation of the Threshold Limit Values* (Ultraviolet Radiation, 2010)
2. Ultraviolet Radiation Quick Reference Sheet (American Industrial Hygiene Association, 2013)