

General UV Terminology

Updated January 26, 2019

absorption – not reflecting. The partial loss in energy from light passing through or not reflecting off a medium.

actinic UV – low powered UVA.

adhesion – state in which two surfaces are stuck together. The degree of force required to separate or destruct the bonds varies by substrate, formulation, and cure. See destruct bond.

ASTM spec D3359-95a – see tape test.

black light – low powered UV composed of longer UVA and near visible wavelengths.

cationic chemistry – UV chemistry that requires minimal direct line-of-sight UV exposure to begin the cure process. The majority of the cure takes place as a chemical reaction that occurs within a few hours or a few days after the UV exposure.

cross hatch test – see tape test.

crosslinking – process of forming covalent bonds or relatively short sequences of chemical bonds to join two polymer chains together. When polymer chains are crosslinked, the material becomes more rigid.

cure – a drying process that occurs through a chemical reaction between a UV formulated ink, coating, or adhesive and UV light.

dose (dosage) – see energy density. Dose is slightly different than energy density in that dose is the total absorbed energy and not the total delivered energy.

dynamic exposure – exposure to a varying irradiance. It occurs when a lamp head passes over a substrate without pausing or when a substrate passes under a lamp head without pausing.

dynamic range – span between the minimum irradiance and the maximum irradiance to which a radiometer will accurately respond. Measured in Joules/cm².

electromagnetic spectrum – full wavelength range of electromagnetic radiation including microwave, ultraviolet, visible, and infrared energy.

energy density – total radiant energy delivered to a particular area (measured in J/cm² or mJ/cm²). Energy density is the integration of irradiance (W/cm² or mW/cm²) over exposure time (line speed or dwell). Though technically incorrect, it is also referred to as dose.

erythemal UV – low powered UVB.

flux – flow of photons and measured in einsteins / second.

free radical chemistry – UV chemistry that requires direct line-of-sight UV exposure in order for the formulation to cure.

frequency – number of times a periodic wavelength cycle occurs in one second. Unit measure of Hertz (Hz) or cycles per second.

germicidal UV – UV in the UVC band.

infrared energy – energy having wavelengths between 1 and 100 μm . Provides a radiated heat component in electrode and microwave UV systems.

intensity – see irradiance.

interlock – internal or external device to the UV source unit. An internal interlock is often a temperature (LED) or pressure sensor (conventional UV) and / or flow meter (liquid-cooled systems) designed into the cooling system to monitor proper conditions and switch off the UV system when conditions are not met. An external interlock is typically implemented by the integrator or machine builder. It is a safety feature to prevent the light source from turning on or to make it shut off under certain conditions, such as when a machine door is open or if the web or parts stop moving.

irradiance – radiant power arriving at the surface from all forward angles. It is usually expressed in watts and milliwatts per square centimeter (W/cm^2 or mW/cm^2). It is independent of line speed and exposure time. It decreases at the cure surface as the distance between the cure surface and the lamp increases. Though technically incorrect, it is also referred to as intensity.

joule – metric unit for measuring work or energy. One joule is equivalent to the work done by a force of one Newton (N) acting through a distance of one meter. It is the time-integral of power. One joule equals one watt per second. Abbreviated J (or mJ for millijoule).

micrometer – metric unit of length equal to one millionth of a meter. Abbreviated μm .

monochromatic – UV output confined to a very narrow bandwidth. UV LED sources are relatively monochromatic. See polychromatic.

monomer – molecule of relatively low molecular weight and simple structure capable of combining with itself or other similar molecules to form polymers.

nanometer – metric unit of length equal to one billionth of a meter (abbreviated nm). It is the most common unit used to describe the wavelength of light, with visible light falling in the region of 400 to 700 nm. Ultraviolet light falls within the range of 200 to 400 nm.

nitrogen blanketing – see nitrogen inerting.

nitrogen inerting – when the surface of the applied formulation is flooded with a nitrogen blanket to prevent the coating or ink from oxidizing before cure. Nitrogen inertion reduces oxygen inhibition.

oligomers – low molecular weight resin or polymer used in a radiation curable formulation.

oxidizing – when the formulation reacts with oxygen and slows the polymerization of the cure. The higher the ratio of exposed surface area to formulation mass, the more negative the impact oxygen has on the cure.

oxygen inhibition – retardation of UV polymerization by the interaction of oxygen with photoinitiators and free radicals. Reduces surface cure of the polymer.

parts per million (PPM) – units of the Threshold Limit Value (TLV) when referring to the maximum level of a substance that a person should be exposed to over an 8-hour shift during a 40-hour week without producing an ill effect. See Threshold Limit Value (TLV).

peak irradiance / peak power density – maximum irradiance or dose rate measured over a sample period. Unit measure of (Joules/cm² · sec) or Watts/cm². See irradiance.

photoinitiator – molecule which when exposed to a specific wavelength of energy starts a reaction that begins the cure process.

photopolymerization – chemical process where a UV formulated ink, coating, or adhesive is converted to a cross-linked polymer through exposure to UV energy.

polychromatic – UV output consisting of a wide bandwidth. See monochromatic.

polymer – a macromolecule consisting of a large number of monomer units.

post cure – chemical or physical reactions in the formulation that occur after UV exposure has ceased.

power density – see irradiance.

radiant power – rate of energy transfer expressed in Watts or Joules/sec.

radiometer – device used to measure incident irradiation on a sensor element. Its construction may incorporate either a thermal detector or a photonic detector. The instantaneous signal output will usually have a linear proportionality to radiant flux and will depend on incident wavelengths. The resulting characteristic response to irradiance versus wavelength is called responsivity.

spectral output – (1) various wavelengths of light emitted from a UV source. (2) the radiant output of a lamp or LED array versus wavelength. Spectral output can be displayed in a variety of ways, but it is commonly shown as a graph or chart illustrating UV irradiance in Watts or Watts/cm² plotted against wavelength. The irradiance can be shown in absolute terms or normalized.

spectral output efficiency graph – graph or chart showing the relative concentration of UV at various wavelengths for a particular bulb (lamp) type. Typically, the concentration is provided as a normalized percentage where the energy is integrated over 10-nanometer bands to reduce the difficulty of quantifying the effects of line emission spectra.

static exposure – exposure to a constant irradiance over a controlled time period.

surface cure – reference to the cure on the outermost material surface exposed to the UV rays.

tape test for measuring adhesion – an X-cut or lattice pattern of 6 or 11 cuts are scratched through the UV cured material to the substrate. Special pressure-sensitive tape is then applied over the cuts and then pulled away. Pulling the tape away from the substrate will reveal the degree of adhesion of the cured formulation to the substrate or media. If any material between the lines is pulled off with the tape, the adhesion is poor. If the cured material remains, the adhesion is good. The recommended guidelines for testing and evaluation are documented in the ASTM spec D3359-95a under Methods A and B. Method A employs the X-cut and is used for films that are greater than 5 mils. Method B calls for lattice cuts and is recommended for films with 0-5 mils thickness.

Threshold Limit Value (TLV) – maximum exposure a person should be exposed to over an 8-hour shift during a 40-hour week without producing an ill effect. Often reported in mg / m³ or parts per million (ppm). See parts per million.

through cure – when the formulation is cured down to and including the material / substrate interface layer. Good through cure does not necessarily mean good adhesion.

Time Weighted Average (TWA) – see threshold limit value (TLV).

total energy – see energy density.

total power – rate of energy transfer expressed in Watts or Joules/sec. For LEDs, total power is measured in an integrating sphere.

transmittance – ratio of the radiant energy passed through a body to the total radiant energy received by the body.

ultraviolet light (UV light) – electromagnetic radiation with wavelengths shorter than visible light and longer than X-rays. UV spans the range of 200 to 400 nm. The name is due to the wavelengths being just outside those identified by the human eye as having the color violet.

UVA (315 – 400 nm) – portion of the electromagnetic spectrum ranging between 315 and 400 nm. UVA represents the largest portion of UV energy and is commonly referred to as long UV. UVA is most responsible for skin aging and increased skin pigmentation. UVA is the lower limit of sensitivity to the human eye.

UVB (280 – 315 nm) – portion of the electromagnetic spectrum ranging between 280 and 315 nm. UVB is most responsible for reddening and burning of the skin and damage to the eyes. Invisible to the human eye.

UVC (200 – 280 nm) – portion of the electromagnetic spectrum ranging between 200 and 280 nm. UVC is commonly referred to as short UV. Invisible to the human eye.

UVV (400 – 445 nm) – portion of the electromagnetic spectrum ranging between 400 and 445 nm. The V stands for visible.

vacuum UV – portion of the electromagnetic spectrum ranging between 100 and 200 nm. UVV does not transmit in air.

viscosity – measure of a fluid’s resistance to flow. Measured in centipoise (cp or cps). Water is 1 cp. Blood is 10 cp. Honey is 2,000 cp.

watt – unit of power, one joule per second.

watt density – see irradiance.

wavelength – distance between corresponding points of a propagated wave. UV wavelengths are typically measured in nanometers (nm). Designations of UV wavelengths are wide ranging and were originally established to define limits for distinction of physiological effects due to UV exposure. Generally accepted ranges include: V-UV 100-200 nm, UV-C 200-280 nm, UV-B 280-315 nm, UV-A 315-400 nm, and UV-V 400-450 nm.