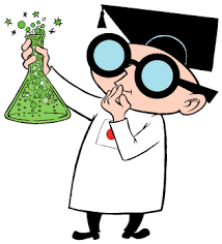
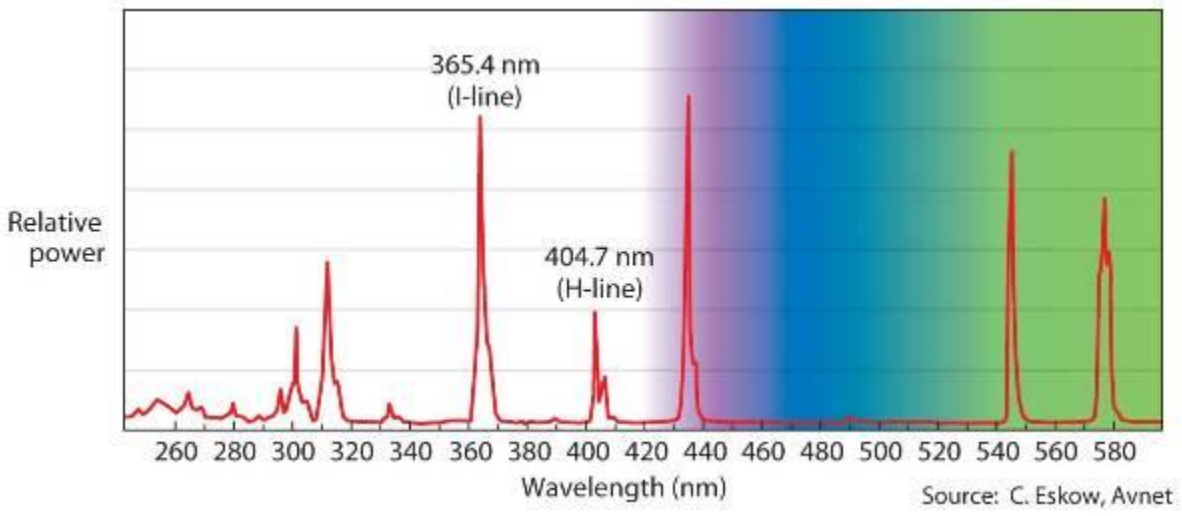


How's it Cooking? UV Measurement Basics

Curing a UV coating is a lot like baking a cake. Following the recipe usually produces the best results, and the chef specifies the cooking process that helps you to accomplish that. For example, you might need to place the cake in a 350-degree oven for 20 minutes. If you take the cake out too early it's gooey, too late and it's overcooked. You also need to watch the oven temperature. Too low and it won't cook in 20 minutes, but neither can you set it to 600 degrees and expect a good result.

In cooking a cake there are two important settings, oven temperature and dwell time. (That is a lot like curing most thermally cured coatings as well). In UV curing there are three important parameters:

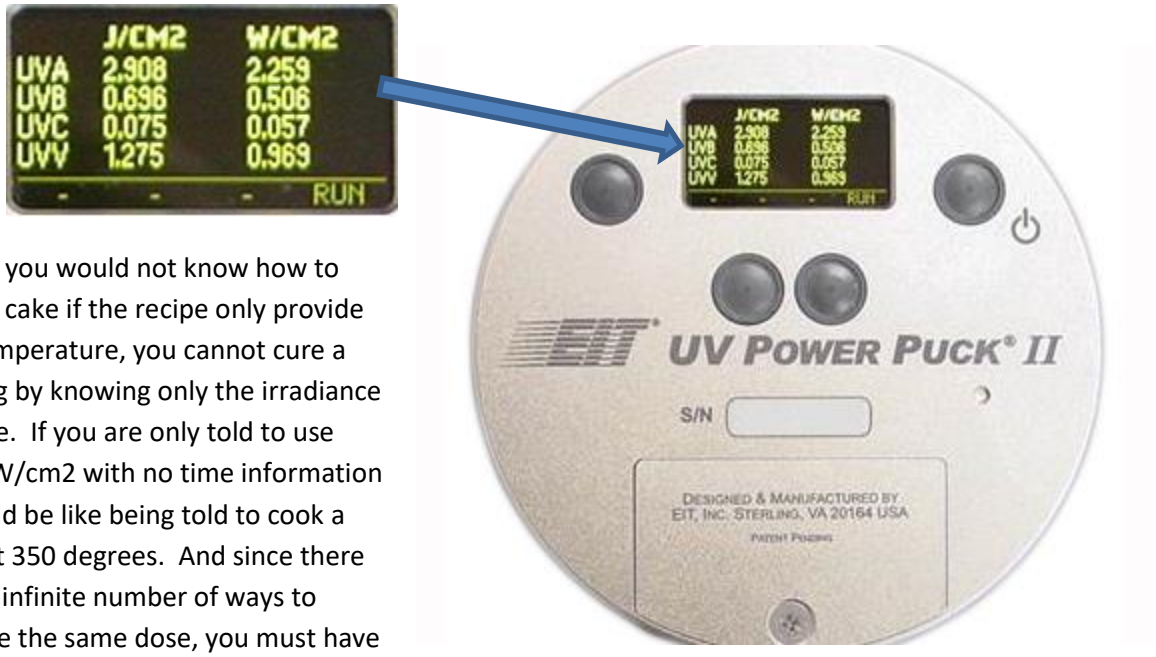
1. **Wavelength.** This is fixed by type of lamp you use. It's usually specified by the coating formulator and is based on the materials (photoinitiators, resins, pigments, and additives) in the coating. The specification might call for a mercury lamp, an iron-doped lamp, or a gallium lamp. To achieve proper performance properties you must cure the coating with the correct wavelength lamp. Some people mistakenly think that a mercury lamp will properly cure any coating. But this is incorrect. Using the wrong wavelength lamp can cause problems with through-cure or surface-cure.



2. **Peak Irradiance**. This is the "brightness" of the lamp. Think about measuring the intensity of a lighting fixture using an old fashion photographer's light meter (the kind with a needle that goes up

when the light is brighter). Imagine the lighting fixture is on a dimmer. If you stand under the light and turn up the dimmer – the needle goes up, indicating greater irradiance. But you can also make the needle move higher by step up a ladder. As you move close to the lamp the irradiance increases, move away and it diminishes. For UV lamps, the intensity is often determined by the design of the lamp, and the adjustment of the power supply, or ballast. An important point is that for any given setting, the peak irradiance does not change as you stand in one place. It's not time dependent (except that the lamp may age slowly over time as we discuss below). Another important note is that if you have a single overhead lamp, and walk across the room with your light meter, the irradiance will be very low when you are far away, and rise sharply as you come under the focus of the bulb. Irradiance is measured in Watts/cm^2

3. **Dose.** Dose is the amount of UV exposure over time. Just as a cake must bake in a 350 degree oven for 20 minutes, a UV coating must be expose to intense UV irradiance for a sufficient amount of time. In fact Does is measured in terms of Joules which is a function of irradiance multiplied by time. 1 Watt/cm^2 of irradiance for 1 second = 1 Joule/cm^2. Since the time of exposure affects does (but not the peak intensity), increasing conveyor speed will reduce dose, but not peak intensity.

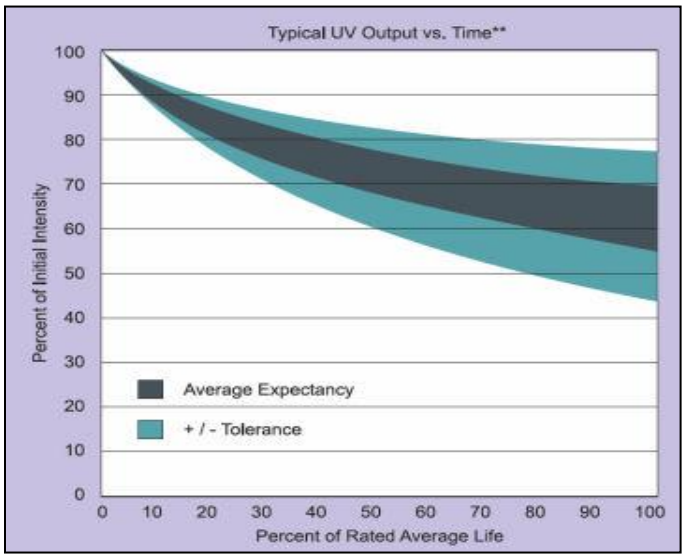


Just as you would not know how to bake a cake if the recipe only provide the temperature, you cannot cure a coating by knowing only the irradiance or dose. If you are only told to use 500mW/cm2 with no time information it would be like being told to cook a cake at 350 degrees. And since there are an infinite number of ways to achieve the same dose, you must have both pieces of information from a formulator to achieve proper cure.

To measure the curing process you should purchase the UV equivalent of the photographer's light meter called a radiometer. A proper radiometer will measure both peak irradiance and dose. The unit measures dose by taking UV measurements many times each second (often taking a measurement in thousandths of a second to accommodate fast moving processes). Each measurement records the

intensity, and the highest measurement is reported as the peak irradiance. Each measurement is also save, and added together with previous measurements to estimate the dose. The higher the sampling rate, the more precisely the peak irradiance and dose can be measured.

In theory, the irradiance of a UV lamp stays the same over time. In reality of course, the lamp ages, and becomes dimmer over time. This degradation is accelerated if the lamp is turned off and on frequently. The irradiance is affected if the lamps reflectors are dirty, or if lamps are positioned improperly after maintenance or setup for different part styles.



Since different radiometer manufacturers use slightly different methods for measuring UV, it's always good to try and use the same radiometer your formulator used to specify the cure process for your coating. Also, since industrial UV light sources can be very intense (and dangerous I not used properly), the instrument should not be left under the UV lamp for extended periods of time, or the heat may cause failure of the device.

Repeated exposure to intense UV also tends to degrade some of the optical components, the unit should be sent in for maintenance and recalibration periodically (ask the radiometer manufacturer for their recommendation). It's also important to protect the quartz window that protects the sensors. Never use a shop rag or scratch the surface with a hard tool since this can impair the instruments performance.

This brief paper is intended to introduce the important topic of UV measurement. You can find more information on UV measurement on the Radtech North America webs site (www.radtech.org) , or by visiting the web site of radiometer manufacturer EIT at http://www.eit.com/uv-products