Measuring UV Cure with the Thin Film Calorimeter

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1. Background
    a. Over the past few years we have made significant improvement in UV LED intensity and in wavelength selection. Currently we offer LED arrays in 450nm, 415nm, 405nm, 395nm, 375nm, 365nm, including a variety of physical formats and die densities. With these vast improvements we then ask the question, "Which is better? "And of course the better on is that which will cure better. So how do we do that? One method suggested by Todd Roper and Dr. Charles Hoyle of the University of Southern Mississippi, is to us a TFC that will measure the exotherm of the curing reaction, as it is curing. This instrument has been produced for the general curing market by UV Process Supply and records the heat created by the curing reaction, the peak heat created, the time to the peak, and the slope of this curve.
    b. The primary application of the TFC instrument relative to this process would be to take an ink, coating, or adhesive and perform the same test using each of the different wavelengths now available. You would then download these test results to and Excel spreadsheet and create a single graph containing each wavelengths curing profile.
    c. Profiling the cure rate with each wavelength and then overlaying these curves will easily identify which wavelength produces the highest peak heat as well as the time required to reach that peak.
    d. Time to peak provides additional critical information for the design stage of your system. To meet targeted production speeds, and while allowing for optimum exposure (Dose) requirements, we now can readily determine the quantity of LED's that will be required to achieve cure.

2. The Test Method
    a. Our experience has found that the required or recommended wavelength outlined on a UV Curable's data sheet does not necessarily dictate the optimum wavelength for LED curing. Only through precise quantitative analysis as outlined can that wavelength be determined.
    b. This particular test method uses a TFC along with the full range of UV LED wavelengths available, and a computer connected to the TFC's communications cable.
    c. A best method for accurate presentation of the sample to the test station is determined. It is important that the film thickness for each test is identical, so the comparative studies relate only to one variable, which is wavelength.

d. When the sampling method has been identified, exposure controls are set on the TFC for a specific test duration, and connection to the computer is verified.
e. The operator selects one of the UV LED's and connects it to the appropriate control interface on the TFC. A sample is placed into the test station, the LED is positioned and the first test is run.
f. After the test is completed, the data collected is downloaded to the computer through the TFC's Data Acquisition Software. Once downloaded, you can preview the curve if you wish and then save the data to a file for later analysis. The test station is cleaned and prepared with another sample, and the process is repeated using each of the remaining LED wavelengths.

3. Reading and Interpreting the Results
    a. The data collected during testing was stored as comma delimited text files, and is now ready for import into any spreadsheet/graphing program such as MS Excel. Once imported and formatted, a simple XY (scatter) chart is created, using smoothed lines and no data points as the preferred style.
    b. Upon completion of the graph, a clear picture comparing the curing results for various wavelengths will emerge.
    c. Identifying the best wavelength from your tests is now as simple as finding the curve with the highest peak, and fastest time to peak.

4. Applying the Findings
    a. The testing, data collection, and graphing process created a clear picture, identifying a wavelength of LED that significantly outperformed all others. It is now time to look a little more closely at that data from the favored wavelength. The goal is to determine key factors necessary for successful curing with UV LED's within the production environment.
    b. By identifying the exact time to peak, you know the exposure (or Dose) required that achieved complete cure. If this is a flood curing or spot curing application you would have all the details required. You simply expose for the amount of time equal to that required for reaching peak.
    c. However, if product will be in motion on a conveyor or other assembly line, further calculation is required. Taking the production speed desired, measure the distance of travel that will occur at that speed and within the same amount of time required to cure. This distance of travel is the exact area of LED illumination that will be required for complete cure.