Chemical and Physical Drying of Coatings between 750–1050 nm: Replacement of furnace technologies

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NIR absorbers based on functionalized polymetines possess the potential to replace older oven techniques by a photonic source namely a high-power NIR LED emitting between 700-1100 nm. These materials facilitate conversion of absorbed light energy into heat as the main component. Therefore, combination of them with NIR sources facilitates film formation of processed coatings on a selected substrate. High power NIR-LEDs have appeared on the scene as their use offers many advantages over corresponding NIR lasers. This work preferably focuses on LEDs emitting at 860 nm, 940 nm or 1050 nm.

There exists a relationship between the structural pattern of the cyanine absorber and generation non-radiative deactivation as main channel to generate heat. Internal conversion proceeding between the lowest vibrational mode of the excited state and a higher vibrational mode of the ground state explains the scenario. Collision of such a hot molecule with matrix molecules fundaments the main process contributing to heat generation. Generated temperature can reach several hundred Celsius degrees. This technology works well even on temperature-sensitive substrates since light absorption and heat generation take place mainly in the coating with high selectivity.

NIR absorbers comprising benzo[c,d]- or benzo[e]indolium pattern absorb between 800-1100 nm with extinction coefficients of several 10^5 $M^{-1}cm^{-1}$. An example shows thermal initiation of a chemical reaction leading to formation of a polyurethane comprising a blocked isocyanate. Temperature generated results in formation of the isocyanate >180°C. This new type of photopolymerization leads to crosslinking.

Compatibility of the absorber, controlled by the molecular pattern of the absorber at different positions, with the matrix can be seen as a further important parameter. Aggregation should be therefore avoided. Photonic drying of coating systems offers the great advantage that the heat required for solidification penetrates directly into the place where it would be needed on demand.