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Pre-formulated One Part Epoxy Vehicles EV110H&L and EV120H&L:

The PII products EV110H & EV110L and EV120H & EV120L are completely formulated, one part epoxies useful for the formulation of screen printing pastes. The vehicles are blend compatible within their own product group, for example: EV110H and EV110L are designed to be blendable while EV120H and EV120L are compatible to blend with one another. However, blends between EV120 and EV110 products may yield unknown results as the two product groups use different curing chemistries.

The compromise in using one part versus two part epoxy systems is mostly related to curing temperatures required and shelf life/curing compromises. One part systems are convenient as the curing stoichiometry is correct and uniform from the factory. This is particularly convenient for screen printing operations were uniformity is more critical. The key to one part systems is to have a system which is relatively shelf life stable at normal storage temperatures yet cure quickly when a certain temperature is reached.

Differences between EV110 and EV120 chemistries can be summed up in the curing chemistries. EV120 requires a minimum cure temperature of about 180°C for effective curing. Lower temperatures even for extended times may not result in an effective cure. As a result EV120 systems typically have long consistent shelf lives to the order of 6 months or more at normal ambient conditions. Also the EV120 system curing and shelf life are relatively insensitive to other additives (solvents in particular) added to the final formulated paste. EV110 systems on the other hand can cure at temperatures of 120°C or even lower. As a trade off shelf life is less, perhaps around 3 months at ambient temperatures and shelf life can be easily worsened by other additives used in the paste formulation. In particular, solvents or other liquid additives can dramatically shorten shelf life. For this reason the only recommended thinner for the EV100 system is carbitol acetate (monoethyl ether or diethylene glycol acetate) and other solvents would require testing before use to see the effect on shelf life of the paste.

Within each system there are ‘H’ and ‘L’ versions which refer to the molecular weight of the epoxy used and thus also the viscosity. ‘L’ versions have a solids content of 97% and use low molecular weight epoxy which will result in lower paste viscosities for a given epoxy solids content and a harder, higher crosslink cured product. This will provide the highest solvent resistance and hardest film. ‘H’ versions contain higher molecular weight epoxy and have higher viscosities even though the solids content is about 69.2%. The ‘H’ versions have lower crosslink density after curing and will result in a slightly lower but most likely still adequate solvent resistance. Also, the ‘H’ systems have a better screen printing nature with better printing and flow characteristics. Furthermore, the ‘H’ systems can be dried yielding a dry tack free print which can later be heated further and cured.

Formulation Guidelines:

First, the required curing temperature is a major selection parameter. The EV110 being a low temperature curing system and the EV120 a higher temperature system. Frequently the substrate to be printed will determine the need for a lower curing temperature. For example if a PET film is printed, excessively high cure temperatures can cause distortion or degradation of the PET and in this situation the lower curing temperature EV110 series is indicated. If printing on a temperature insensitive substrate like alumina, a system based on EV120 chemistry will yield longer shelf life pastes.

All of these systems are fully formulated with adhesion aids and rheology characteristics to make final pastes with the addition of desired fillers. With the abilities to blend 'H' and 'L' versions, vary the ratio with the filler, and thin further with solvents, this system makes it possible to use a wide range of fillers and filler loading levels. For the formulation of conductive pastes it is typical to blend in the conductive filler at a VOLUME loading level of about 30-60% or more depending on the characteristics desired. As one example, if one wants to make a conductive silver paste it would be useful to start at about a 30 v/v% silver level for the final dried paste. Since the density of silver is 10.5 g/cc, then a starting point would be taking 50 grams of silver which equals 4.75 cc (50g / 10.53 g/cc=4.75 cc). As this would be 30 v/v% of the dried paste it means we need 4.75cc/.3=15.83cc total paste volume or 15.83cc-4.75cc = 11.08cc of dried epoxy phase. The density of the epoxy systems are about 1 g/cc so we would need about 11.08 grams of dried epoxy. If for this example we would use all 'H' series product, which is 69.2% solids, then we would need 11.08/.692 = 16.01 grams of 'H' series epoxy. So finally, if one blend 50 grams of silver with 16.01 grams of either EV110H or EV120H it should result in a system which is 30 v/v% conductive phase and should be conductive depending on the filler morphology. So further, if one blends 50 grams of silver with 16.01 grams of 'H' type vehicle and the viscosity is higher than desired it is possible to blend in solvent to get the desired viscosity without changing the ratio of silver to dried epoxy phase in the final cured paste or to substitute in some amount of 'L' series vehicle taking into account the 'L' system higher solids content.

One possibility to experiment with the capabilities of the system is to make a system with the correct 30v/v% ratio of metal to dried epoxy in both an 'H' and 'L' system and look at them individually and make several blends between the two to find the desired printing and other paste characteristics. Further in our example we used 30 v/v%, but it is often advantageous to use higher metal loadings in the final dried film for better conductivity (or other characteristics) so the above blending experiment can be repeated at a higher loading such as 50 v/v% or even higher to see the range of paste characteristics possible.

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