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Coating Innovations
for Electronics

TI TECHNICAL INFORMATION

TI 15/10: Processing of 2-pack systems

Experience has proved that in the processing of 2-pack systems such as solder resists or casting compounds, mistakes are made time and again that could be avoided if all processing parameters were observed. In general, the printing of 2-pack solder resists on printed circuit boards or the casting of electronic components is one of the final processing steps of an almost finished product so that errors in the processing of such 2-pack systems can cause enormous damage.

Owing to excessive or incomplete cross-linking, a 2-pack system that has not been mixed in the correct mixing ratio, or that is not homogenous, necessarily results in property values that are different from those stated in the Technical Report. In order to avoid errors in the processing of such systems, the understanding of the individual process phases is as important as the observance of the specified parameters. This Technical Information sheet provides a detailed overview of the processing of 2-pack systems.

Contents

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Processing of 2-pack systems

Preparation of components

➔ Prior to processing, both components should have slowly adopted the temperature at which they will be processed. Make sure that the individual components definitely belong together.

➔ If necessary stir up the two components.

This is necessary if colour pigments, fillers or other components are contained which may settle after prolonged storage. In this case both containers show by the following symbol:

Stir before use

Mixing ratio

In case of a 2-pack system the quantity of resin (component A) has been adjusted to match the quantity of the hardener (component B) in order to achieve a 100 % degree of cross-linking. This is the mixing ratio indicated in our Technical Reports and on container labels.

The mixing ratio of the components A and B is indicated in parts by weight. Both components have been packed in the correct mixing ratio. As a rule, the volume of the container of component A is sufficiently large so that the entire volume of component B can be added. When preparing a different batch quantity the item “Preparation of partial batches” must be observed.

Preparation of partial batches

The mixing ratio of our 2-pack systems is indicated in parts by weight. When partial batches are prepared, both components have to be weighed according to the mixing ratio. If mixing is effected volumetrically, the corresponding volume portions must be converted using the mixing ratio and the densities of the components A and B.

Conversion: $\rho = m/V$

$V = m/\rho$

ρ = density [g/cm³]

V = volume [cm³]

M = weight [g]

Example:
Casting compound **Wepuran VU 4457/41**: mixing ratio = 4 : 1 (parts by weight)

$\rho_{comp.\ A}$ = 1,44 g/cm³

$\rho_{comp.\ B}$ = 1,21 g/cm³

$$V_{comp.A} = \frac{4\ \text{parts by weight [g]}}{1.44\ [\text{g/cm}^3]} \approx 2.7777\ \text{vol. parts [cm}^3]$$

$$V_{comp.\ B} = \frac{1\ \text{part by weight [g/cm}^3]}{1.21\ [\text{g/cm}^3]} \approx 0.8264\ \text{vol. parts [cm}^3]$$

Mixing ratio (volume parts) = 2.7777 : 0.8264 ≈ 10 : 3

Mixing

➔ Mix both components based on the indicated mixing ratio.

➔ Mix components A and B completely, making sure that no unmixed material remains in the corners of the containers.

When 2-pack systems are mixed in the standard containers supplied, component B has to be poured completely into the container of component A. Excessive residual adhesions do not only cause losses of material but also result in higher disposal cost.

➔ When mixing solvent-containing 2-pack systems the explosion protection guidelines should be observed. Make sure that there is sufficient ventilation and use a stirrer equipped with an explosion protection.

The advantages and disadvantages of the common mixing methods are detailed below.

➔ Use a mechanical stirring device with an appropriate stirrer if possible.

➔ Ensure that no air is entrapped during mixing.

Manual mixing

Mixing by hand is not recommended because the user will normally find it very laborious and therefore runs the risk of not stirring sufficiently or too briefly, in such a way that no homogenous mixture is achieved.

Manual mixing involves the risk of the stirring rod not reaching into the corners of the containers, the so-called "dead zones" (refer to fig. 1).

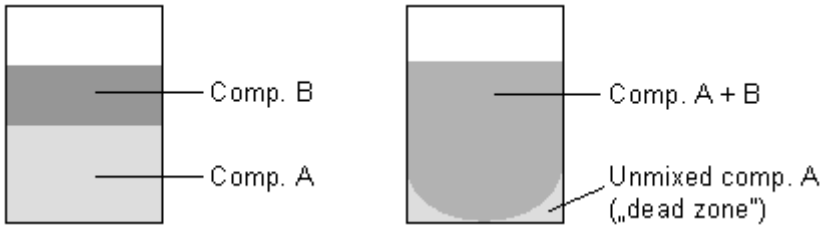


Fig. 1: Unmixed material "dead zones" after the mixing process

Mixing with household appliances / propeller stirrers / drills

Household mixers, propeller stirrers or drills are inappropriate since considerable quantities of air are included in the system during stirring.

Suitable mixing elements

A suitable mixing implement not only reaches into the corners ("dead zones") of the mixing vessel but also ensures mixing without excessive air inclusion.

In addition, we suggest transferring the final mixture into an empty vessel and remixing it. By this means, the so-called "dead zones" (see fig. 1) are also emptied.

The following mixing elements are recommended:

- **Stirrer shaft with basket / basket stirrer**

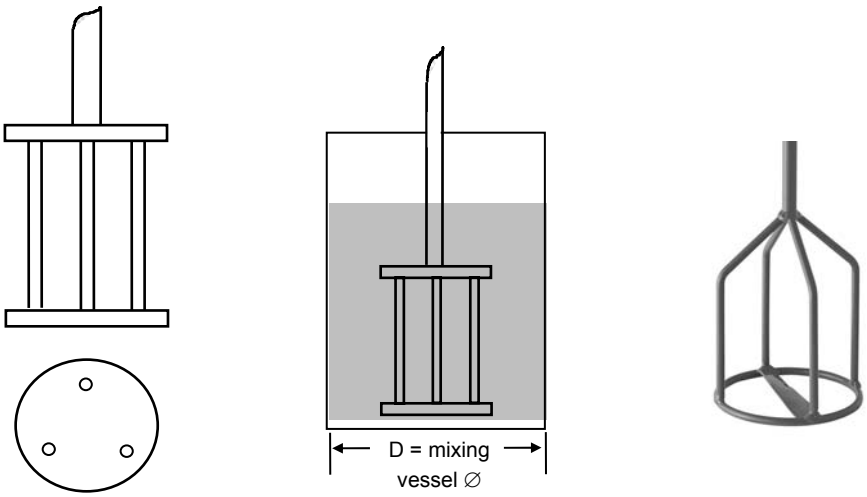
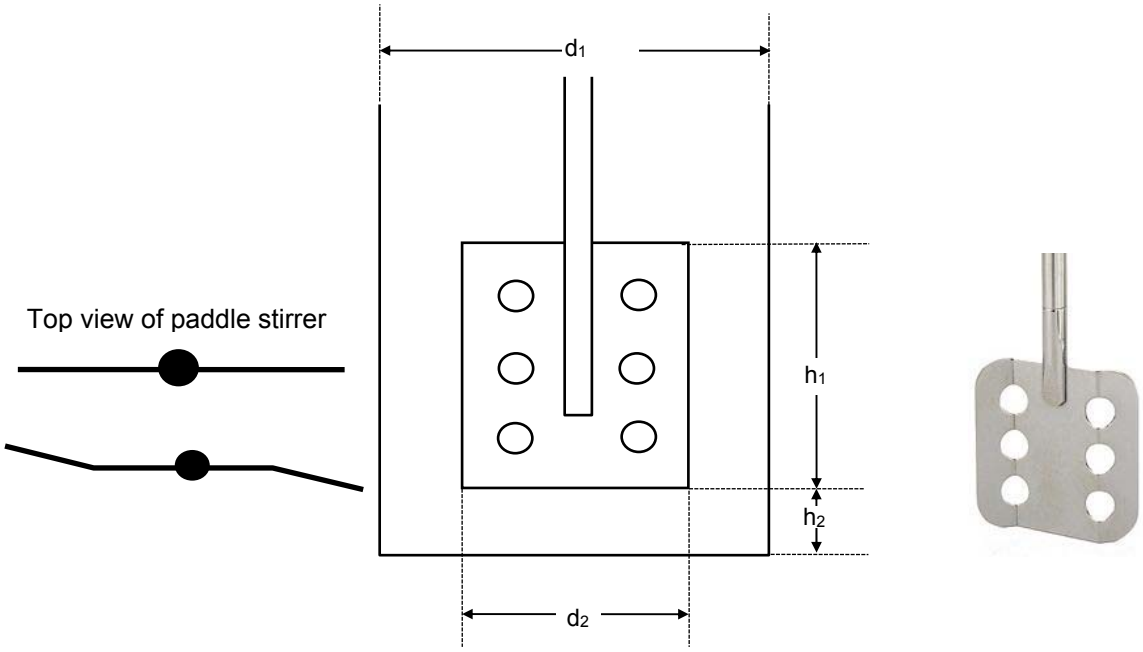


Fig. 2: Basket stirrer
Source of right picture: Collomix Rühr- und Mischgeräte GmbH, Gaimersheim, Germany

The diameter of the agitator basket depends on the diameter of the mixing vessel. In practical operation, an agitator basket diameter of about one-third of the mixing vessel diameter has proved to be the optimum configuration. The height of the agitator basket should exceed the diameter.

- **Paddle stirrer with bores (straight or with angular paddle ends)**



Paddle stirrer with bores
Source of right picture: Bochem Instrumente GmbH, Weilburg, Germany

The diameter of the paddle stirrer depends on the diameter of the mixing vessel. In practical operation, the following ratios have been tried and tested:

$d_2/d_1 = 0.6$

$h_1/d_1 = 1.25$

$h_2/d_2 = 0.2$

A list of suppliers for laboratory stirring implements is made available upon request.

Mixing and dosing equipment

For a higher consumption, the use of a mixing and dosing unit is advisable. The more favourable price of large containers and the avoidance of mixing and weighing errors redeem the purchase price of this equipment if more than 200 kg are consumed per month.

A list of manufacturers of mixing and dosing units is available upon request.

Degassing of mixture

Air that has been stirred in (revealed by excessive foaming) may cause entrapped air or bubbles that may affect the final properties of coatings and pottings.
When air has been stirred into solvent-free casting compound, a degassing under vacuum has to be effected.
With coatings that contain solvents, e.g. 2 pack solder resists, the air will generally escape after a short standing time.

Pot life

EN ISO 4618:2006 defines the processing time/pot life as “the maximum time period in which a coating material supplied in separate components should be processed after the mixing cycle”.

The pot life is limited by the advanced cross-linking of the two components and thus the increase of viscosity resulting from this.

➔ Prepare a batch quantity that can be properly processed during the pot-life.

In our “Technical Reports” the pot-life is indicated under the item "Characteristics". Unless otherwise specified, the indication of the pot-life always applies to a 500 g standard batch preparation.

Smaller batches exhibit a longer pot-life; large batches may result in a substantially shorter pot-life, particularly depending on solvent-free products and also depending on the resin/hardener system.

In the case of a prolonged standing time in the pot, the 2-pack system should be stirred again for a short period prior to application.

Curing

The curing or cross-linking (the latter term being used primarily for silicone-rubber casting compounds) is made by polyaddition of the components A and B.

Curing is effected in a drying oven or, for cold-curing 2-pack systems, at room temperature. The curing parameters are listed in the relevant Technical Reports.

A list of drying oven suppliers will be provided upon request.

The following points should be observed in the curing process:

Temperature distribution

The preset temperature does not always comply with the actual dryer temperature (depending on the location of the heat sensor). Even in modern dryers, a uniform temperature distribution is not always guaranteed. In order to be on the safe side, a temperature profile should be established for every dryer. The dryer should then be adjusted according to this temperature profile so that the burn-in temperature required for an adequate cross-linking is reached in the entire dryer chamber.

Exhaust

Particularly with solvent-containing 2-pack systems such as solder resists, adequate ventilation, mainly in the initial phase of the curing process, must be ensured for the following reasons:
In the initial stages of the curing phase, the major part of the solvents evaporates. Unless adequate ventilation is provided in this initial phase, these released solvents can condensate in the air and settle on the surface of the uncured 2-pack system. Part of the resist could then be washed off again. This results in a curtain effect after the burn-in (baking) phase. In order to avoid this surface defect, the printed circuit boards should not be stacked too tightly in the oven and the oven should be operated with both fresh and exhaust air, at least during the first ten minutes. If this is not possible, the printed circuit boards should be left to exhaust for about 15 minutes at room temperature prior to baking.

Burn-in time/object holding time

An inadequate burn-in time (too short) may be caused by ignoring the heating-up time specified for the oven. The burn-in conditions indicated by us refer to the so-called object holding time, meaning that the actual curing time does not start until the printed circuit board has reached the desired curing temperature. When a drying oven, for instance, is stacked with a complete rack of printed circuit boards, the entire cold contents of the oven - printed circuit boards and rack car has to be heated up to the burn-in temperature first. According to experience, this lasts about 10 - 15 minutes. This time, that has to be determined empirically in each case, has to be added to the net burn-in time. A corresponding control mechanism which ensures the predetermined burn-in time is not recorded until the oven has reached the preset temperature, should be used. Qualified manufacturers of drying ovens offer their assistance regarding the setting of such controls.
Never open the drying oven during the burn-in time in order to load or unload any objects.

Simultaneous curing of different coating systems or multiple layers

If printed circuit boards are printed with coating two or more times, or if a marking ink is to be printed onto a solder resist, the following should be observed: In order to achieve perfect adhesion of the subsequent coating, the previously printed coating should only be burnt in until a tack-free surface is accomplished. After the final printing process, the printed circuit board is cured once over the full period at the burn-in temperature of the coating used last. This saves time and simultaneously improves the adhesion among the individual coatings.

Verification of curing and wetting result – quality assurance measures

Defective final products can be detected by means of simple testing methods.

Gloss degree of coating surface

When mat coatings, e.g. mat solder resists are applied, inadequate mixing may not be detected sufficiently upon visual inspection of the printed circuit board’s coating surface. In case of silk-mat, silk-glossy or glossy coating surfaces, an inadequate mixing of the individual components is indicated by the more or less intensive difference in the degree of gloss. Since this must always be interpreted as the result of excessive or inadequate cross-linking which can impair all dielectric properties, the electrical property values should be checked.

Methylene chloride test

A very simple and, at the same time, safe test for controlling cross-linking, is to check the methylene chloride resistance. The 2-pack solder resists must withstand the storage in methylene chloride (dichloromethane) at room temperature, for the time indicated in the Technical Report, without suffering incipient dissolution or softening.

A more or less intensive incipient dissolution or even a complete dissolution are sure signs of inadequate mixing and/or insufficient curing.

Pencil hardness

Solder resists can be verified easily and rapidly by measuring the pencil hardness.

Shore hardness

The degree of cross-linking of casting resins and casting components can be checked by measuring the Shore-hardness. Curing/cross-linking is completed when the Shore-hardness measured has reached the value indicated in the Technical Report.

Other tests

Within the scope of this Technical Information sheet we cannot list individual tests to determine the mechanical, thermal and electrical property values. In our technical reports you will find information on the properties of each product stating the respective test standards.

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Any questions?

We would be pleased to offer you advice and assistance in solving your problems. Samples and technical literature are available upon request.

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