RIGID.FLEX WITH FLEXIBLE SOLDERMASK OR COVERLAY?
AGENDA

RIGID.flex with flexible soldermask or coverlay?

1. Intro

2. Coverlay
   ▪ Introduction and properties
   ▪ Application
   ▪ Design

3. Flexmask / Covercoat
   ▪ Introduction and properties
   ▪ Application
   ▪ Design

4. Benchmark / Summary
   ▪ Comparison

Werner Öchslen
Technical Project Management
A variety of possible materials and material combinations exist for flexible circuits. This webinar provides an overview of flexible covercoats and coverlays and their usage with RIDIG.flex.
COVERLAY AND COVERCOAT

Basic functions

- Encapsulation of conductors to protect against corrosion and oxidation
- Protection against environmental influences
- Bendability
  - Flex to Install
  - Dynamical bending
What is Coverlay?

- Composite of polyimide and adhesive
- Polyimide: 12.5 µm, 25 µm or 50 µm
- Adhesive thickness: 25 µm, 35 µm or 50 µm (acrylic/epoxy)
- Protection of conductors on inner and outer layer

What are its characteristics?

- Available as flame retardant V-0
- Thermal conductivity 0.2 W m\(^{-1}\) K\(^{-1}\)
- Dielectric strength ≥ 4 kV/mil
- Low outgassing
# COVERLAY

Types and properties

<table>
<thead>
<tr>
<th>Coverlay</th>
<th>Application</th>
<th>Layer allocation</th>
<th>Positioning accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>Manual as Sheet Material in flex and rigid parts</td>
<td>Innerlayer / Outerlayer</td>
<td>+/- 150µm</td>
</tr>
</tbody>
</table>

![Diagram of Coverlay Application Manual as Sheet Material in flex and rigid parts](image)
Coverlay

Example Flexrigid xRi-2F-xRi

Material LF-Prepreg VS

Material Kern VS

Verstifen

5-er Pack

Fräsen

Material Kern RS

Material LF-Prepreg RS

Verstifen

5-er Pack

Fräsen

Material Kern VS

Material Kern RS

Verstifen

5-er Pack

Fräsen

Material Kerne VS

FD IL

DES

AOI

Coverlay Fixieren

Coverlay Verpressen

Material Coverlay Film VS / RS

Flex-Material Innenaufge

Sammelplatz

ML Verlegen

ML Vepressen

ML Fertigung Standard

Tieffräsen VS + RS

ML Fertigung Standard

Coverlay Fixieren

Coverlay Verpressen

Schneiden Coverlay

Material Kerne VS

FD IL

DES

AOI

A-PREP

Sticheln

Material Kerne VS

FD IL

DES

AOI

A-PREP

Sticheln

Material Kerne RS

FD IL

DES

AOI

A-PREP

Sticheln

Fräsen
COVERLAY
Example flexinnerlayer xRi-2F-xRi

- cutting
- registration
- fixing
- pressing
What is Covercoat?

- thin lacquer-like layer of unfilled polymers, polymer mixtures, epoxy, pigments, solvents
- Layer thickness: protection of conductors on outer layers

What are its characteristics?

- Available as flame retardant V-0
- Low coefficient of thermal expansion
- High surface adhesion
- Good thermal stability
- Very good resolution (photoimaged coatings)
- Cost-effective (non-photoimaged coatings)
### COVERCOAT

Types and properties

<table>
<thead>
<tr>
<th></th>
<th>Photoimaged Covercoat</th>
<th>Non-photoimaged Covercoat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>Screen printing / Spray</td>
<td>Screen printing / Inkjet</td>
</tr>
<tr>
<td>Layer allocation</td>
<td>Outer layer</td>
<td>Outer layer</td>
</tr>
<tr>
<td>Positioning accuracy</td>
<td>± 50 µm</td>
<td>± 200 µm</td>
</tr>
</tbody>
</table>
COVERCOAT

Application

by Inkjet:

- pre-cleaning
- Inkjet printing
- UV-curing
- thermal curing

by screen printing:

- create screen
- pre-cleaning
- screen printing
- thermal curing
- screen washout
COVERCOAT

Not Photosensitive Covercoat

- Application by Inkjet
- Only in flexible area
- Distance to pads: 200 µm
APPLICATION IN THE WE PORTFOLIO "FLEX SOLUTIONS"

Selection notes

RIGID.flex 1F-xRi

Covercoat outer layer
Coverlay outer layer

RIGID.flex 2F-xRi

Covercoat outer layer
Coverlay inner + outer layer

WEBINAR | 09.2023
APPLICATION IN THE WE PORTFOLIO "FLEX SOLUTIONS"

Selection notes

**RIGID.flex xRi-2F-xRi**
- Coverlay inner layer

**PURE.flex**
- Covercoat outer layer
  - Coverlay outer layer
## Benchmark Flexmask or Coverlay?

Costs / technical

<table>
<thead>
<tr>
<th></th>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexmask</td>
<td>Costs</td>
<td>Only partly (2 coatingsystems necessary)</td>
</tr>
<tr>
<td>not photosensitiv</td>
<td>Small flexareas possible</td>
<td></td>
</tr>
<tr>
<td>Flexmask</td>
<td>Cost</td>
<td>No thick copper possible (only in prototypeplant used)</td>
</tr>
<tr>
<td>photosensitiv</td>
<td>(1 coatingsystem)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Small flexareas possible</td>
<td></td>
</tr>
<tr>
<td>Coverlay</td>
<td>Different thicknesses</td>
<td>Position accuracy</td>
</tr>
<tr>
<td></td>
<td>Isolation</td>
<td>Cost – manual workload</td>
</tr>
<tr>
<td></td>
<td>Dynamical bending</td>
<td></td>
</tr>
<tr>
<td></td>
<td>abrasion resistance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>„you always get the same in the market“</td>
<td></td>
</tr>
</tbody>
</table>
BENCHMARK FLEXMASK OR COVERLAY?

Tipps and Tricks

USING ARRAYS

- Less workload
- Better registration
BENCHMARK FLEXMASK OR COVERLAY?

Tipps and Tricks

- **FLEX LiftOff**

- Bending with flexmask in the inner radius
  - Polyimide looks outside for insulation

- **FLEX LiftOff**
  - Bending begins in the rigid area
LITERATURE

Design Guide Flex Solutions

In our Design Guide you will find an overview of all variants of our flex solutions. In addition, our specialists have summarized valuable design tips for you here. This will help you bring your application to success reliably and safely.

- New issue: September 2023
- New contents
  - Combination HDI & RIGID.flex
  - Signal integrity with RIGID.flex
  - Basic properties
  - Impedance defined stackups
  - Impedance measurement
  - Comparison flexible soldermask versus Coverlay
  - Coverlay as insulation foil
LITERATURE

Design Guide Flex Solution - Excerpt

EXAMPLES

Flex outside left flex solder resist
Center coverlay
Right Flex inside with Coverlay

FLEXIBLE SOLDER RESIST OR COVERCOAT

Flexible soldermask is a varnish, i.e. a mixture of binder, solvent and pigments. In contrast to solder resist for rigid printed circuit boards, flex resist remains flexible after curing, ideally resistant to folding. Flex varnish is applied by inkjet or screen printing.

COVERLAY OR COVER FILM

Coverlay is a composite film consisting of polyamide film and adhesive layer. Polyamide film thickness standard 25 µm, adhesive thickness matching the copper layer thickness. Other polyamide film thicknesses optional. Cutting or laser, manual registration and tacking, pressing in vacuum press.

WHEN CAN I CHOOSE BETWEEN FLEXIBLE SOLDERMASK AND COVERLAY?

The choice is only possible for the variants with 1F+Al and 2F+Al outer flex layers - and even then only for the outer layer. With Stackup 2F+Al, copper layer 2 is always protected with a Coverlay, as are all copper layers with inner flex layers. With PURE.Flex, it is also possible to choose between flex coating and overlay.

COMPARISON OF SELECTED PROPERTIES

<table>
<thead>
<tr>
<th></th>
<th>Flexible soldermask</th>
<th>Coverlay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>Green</td>
<td>Amber/brown</td>
</tr>
<tr>
<td>Composition</td>
<td>Mixture of binder, solvent and pigments</td>
<td>Composite film of polyamide film and adhesive layer</td>
</tr>
<tr>
<td>Registration</td>
<td>Automatic, optical</td>
<td>Mechanical</td>
</tr>
<tr>
<td>Application</td>
<td>Liquid by inkjet or screen printing</td>
<td>Manual application, vacuum lamination</td>
</tr>
<tr>
<td>Structuring</td>
<td>Partial application, photo process</td>
<td>Cutting, lasering</td>
</tr>
<tr>
<td>Design</td>
<td>Very variable, small individual areas possible</td>
<td>Small individual areas must be connected in the PCB and/or in the delivery array</td>
</tr>
<tr>
<td>Dynamic bonding</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Applicable to inner layers</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Applicable to outer layers</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Maximum copper thickness</td>
<td>up to 70 µm</td>
<td>up to 70 µm</td>
</tr>
<tr>
<td>Minimum distance vias and pads to rigid/flex interaction</td>
<td>Smaller, see Design Rules parameter “G”</td>
<td>Larger, see Design Rules parameter “G”</td>
</tr>
<tr>
<td>Use in vacuum</td>
<td>Limited</td>
<td>Very good</td>
</tr>
<tr>
<td>Mechanical/robustness</td>
<td>Lacquer with pencil hardness ≥ 3H</td>
<td>Resistant film</td>
</tr>
<tr>
<td>Dielectric strength</td>
<td>Approx. 150 V at 5 µm thickness</td>
<td>Approx. 3500 V/ml (1 mIl = 25.4 µm)</td>
</tr>
<tr>
<td>Tainting of microvias</td>
<td>Limited</td>
<td>Yes</td>
</tr>
<tr>
<td>UL Listing</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Effort and cost</td>
<td>Low effort, inexpensive</td>
<td>High effort, more expensive</td>
</tr>
</tbody>
</table>

COVERLAY AS INSULATION FOIL

Coverlay foil can be used as a protective and insulating foil, both on the rigid areas of a STARR.Flex PCB and on rigid BASIC or HDI PCBs.
SUMMARY

Design guide with advantages and disadvantages
(technical and commercial)

Decision Flexmask or Coverlay
(WE Standard: Flexmask)

Selection of design parameters in the design rules
THANK YOU VERY MUCH FOR YOUR ATTENTION

You have the choice: RIGID.flex with flexible soldermask or coverlay?