Liquid Resist - Applications & Practical Uses

A joint presentation of ahk & HTP

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ahk & HTP – a long joint history

HiTech Photopolymere AG

Founded in 1997 by former CIBA-Geigy employees from the R&D and sales department for photoresist technology

ahk Lösungen durch Technik

Founded in 2005, established itself as a reliable partner in the development, manufacturing, and installation of high-quality coating & Drying systems.

Cooperation began on a personal basis even before ahk was officially founded

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Photoresist – long story short

- First inventions in the 19th century

- Major improvements and industrial use starts in the middle of the 20th century
- Major inventions in modern life and widespread establishing of technology are based on the usage of photoresist for etching applications






→ Photoresists are a powerful and essential tool especially for the PCM and the PCB industry

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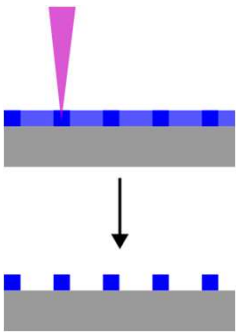
Types of photoresist

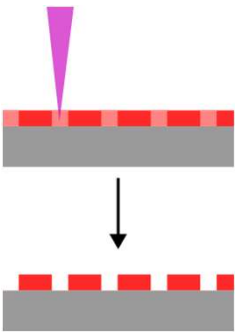
Negative working

- Dry film
- Liquid photoresist



Positive working

- Liquid photoresist



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Types of photoresist

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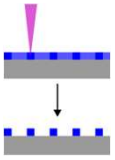
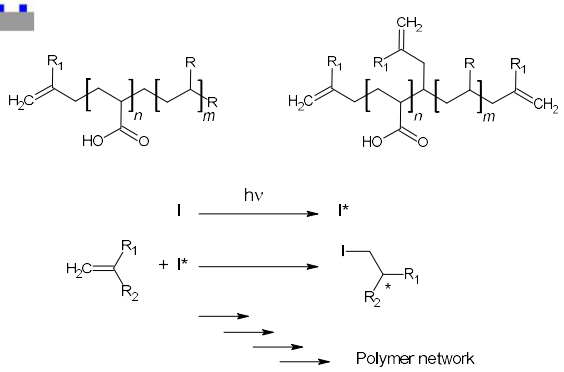
- Liquid photoresist



1) Acrylate resist

- Low molecular weight polymer with 1 or more acrylate functions
- Photoinitiator initiations a local radical polymerization

  → polymer network is in-soluble in the developer



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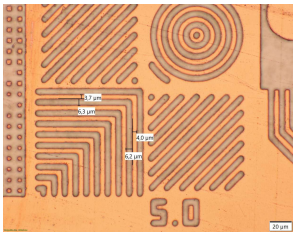
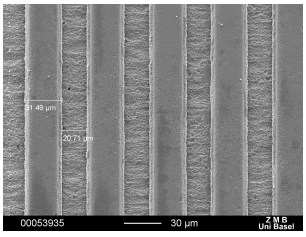
Properties of acrylate resists

- High photoreactivity
- High to medium resolution depending on resist composition, film thickness etc.
- Widely used technology – same DES chemistry as dry film
- Oxygen inhibition in the top part of the film possible
- Limited shelf-life due to selfreaction after certain time in absence of inhibitor



Resist type:	DET765.12	DiaEtch 300
Film thickness:	3 µm	12-15 µm
Exposure energy:	25 mJ	40 mJ
Exposure equipment:	Schmoll MDI	hard contact



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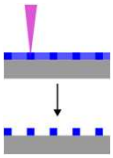
Types of photoresist

Negative working

- Dry film
- Liquid photoresist

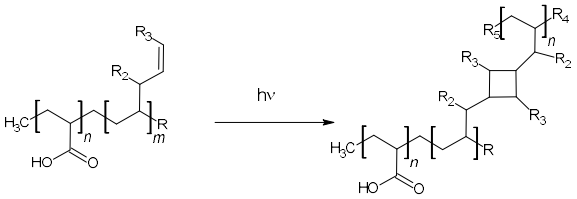


2) Dimerisation resist

- Low molecular weight polymer with dimerisation groups
- Photoinitiator initiations the dimerisation

  → polymer network is in-soluble in the developer

wearase unexposed polymer is highly soluble



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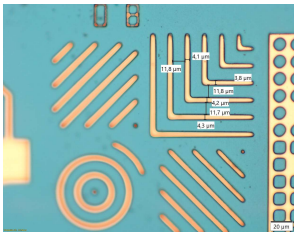
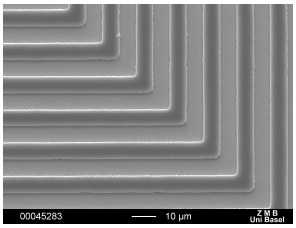
Properties of dimerisation resist

- Medium photoreactivity
- High resolution depending on resist composition, film thickness etc.
- No oxygen inhibition → processing of very thin layers is possible
- Same DES chemistry as dry film
- Long shelf-life and very long resist stability



Resist type:	DET539
Film Thickness:	3 µm
Exposure energy:	200 mJ
Exposure equipment:	left: Schmoll MDI right: hard contact



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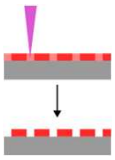
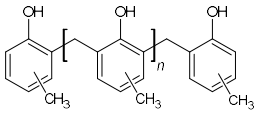
Types of photoresist

Positive working

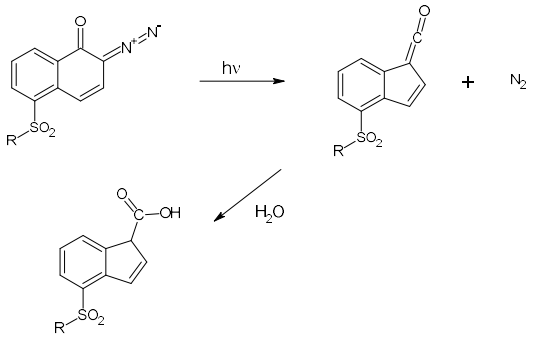
- Liquid photoresist



- Polymer binder is a slowly soluble novolac

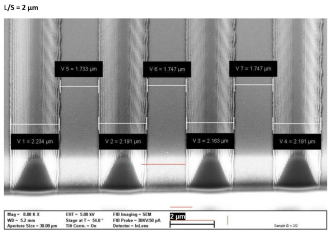


- Photoreactive group is a diazo compound

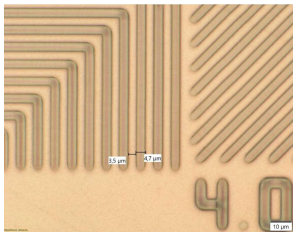


Properties of positive resist

- Allows high resolution in thin layers
- Film thickness from several 100 nm up to appr. 8 - 10 µm (no oxigen inhibition)
- Requires a few minutes hold-time after exposure
- As developer a diluted sodium hydroxide solution is recommended
- Allows processing in acidic and slightly alkaline conditions.
- Multiple step exposure is possible
- Dissolves in stripping process (no flakes)

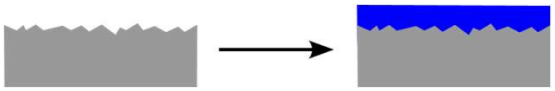


Resist type:	DET895	
Film thickness:	left: 2 µm	right: 6 µm
Exposure energy:	400 mJ	
Exposure equipment:	Schmoll MDI	



Why using liquid photoresist

- **Superior adhesion with gentle pretreatment**
  - **E.g. degreasing with solvent or alkali and maybe microroughness with pumice or microetch for good wettability**



Comparison to dryfilm:

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Why using liquid photoresist

- **Superior adhesion with gentle pretreatment**
  - **E.g. degreasing with solvent or alkali and microroughness with pumice or microetch for good wettability**

- **High flexibility regarding substrate shape, thickness and surface topography**
  - **E.g. 20 µm thick foils, thin or thick plates, cylinders**
  - **E.g. second coating at a pre-etched surface; ruler with a deep engraved line**

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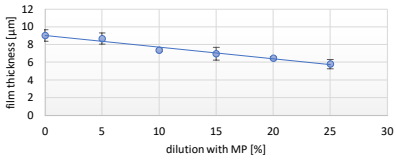
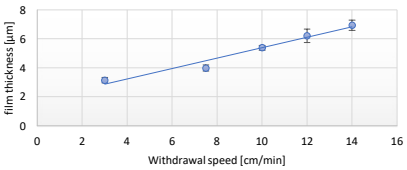
Why using liquid photoresist

- **Superior adhesion with gentle pretreatment**
- **High flexibility regarding substrate shape, thickness and surface topography**
- **Excellent repeat accuracy with easily controlled parameters**
- **Easy adjustment of layer thickness**
  - **E.g. dip-coating: viscosity and withdrawal speed**

DiaEtch 300 - film thickness vs dilution at 10 cm/min



DET765.12 – film thickness vs withdrawal speed



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Why using liquid photoresist

- **Superior adhesion with gentle pretreatment**
- **High flexibility regarding substrate shape, thickness and surface topography**
- **Excellent repeat accuracy with easily controlled parameters**
- **Easy adjustment of layer thickness**
- **Economical and ecological efficient**
  - **Nearly no waste**
  - **Layer can be as thick as required, but as thin as possible**
- **Resist production from small to large batchsizes possible**

  → custom made products for special applications

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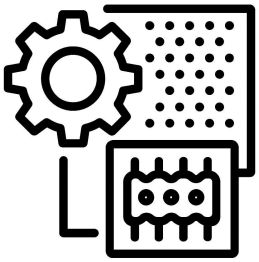
Integration in current production process?



1. Pre-cleaning
2. Lamination
3. Coating
4. Peel off mylar foil
5. Drying
6. Exposure
7. DES-Line

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How many of you have asked yourselves whether liquid resist could solve an issue in your existing production line?

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Overview

Coating Techniques for Liquid PR established for PCM

1 **Roller-Coating**
For flat sheets, Requires accuracy made for big batch sizes

X **Spin-Coating**
Mainly used in microelectronics, **less suitable for PCM**

2 **Spray-Coating**
Useful for complex shapes or when topographic coating is needed

3 **Dip-Coating**
Good for small to medium batch sizes, Good for thin & thick material

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ahk Service & Solutions – practical uses for coating

Roller-Coating
- Dies for Cutting, Embossing (single etched)
- Electroforming parts
- Precised milling parts

Spray-Coating
- Dies for Cutting, Embossing (single & multiple etched)
- Electroforming parts
- Precised milling parts

Dip-Coating
- Dies for Cutting, Embossing (single & multiple etched)
- Electroforming parts
- Precised milling parts
- Measuring tools
- Cliché for pad printing
- Engraving for 3D parts (cylinder, Sword)
- Encoder ribbon (Reel:Reel)

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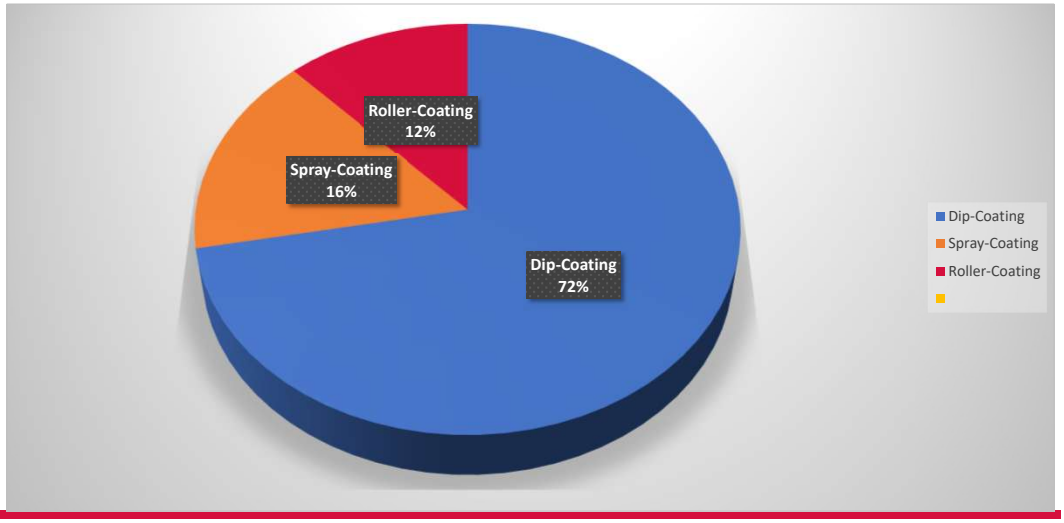
A quick inside from ahk customer



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1st Case: Spray-Coating Project

This case is about producing **high-precision embossing plates** used for credit card security features – a **highly sensitive and regulated** application. The product was previously made by an external supplier. Due to sensitive data, the plates should now be produced in-house.

Apporach
Setup a new plant - the initial approach relied on **screen printing** to apply the resist layer. But there were issues…

Challenges
- The coating was **too thick and uneven**,
- **Manual handling** generated dust and particles,
- And it was simply hard to control – especially in a **class 1000 cleanroom**

Result
spray-coating system, combined with **inline drying** – this allowed:

- **More uniform, thinner coatings** with high resolutions
- **Faster processing**,
- less contamination risk.

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2nd case Dip-Coating Project

This project is about **engraved steel rulers and scales** – used in many industries and have been realized at Starrett in the US

The historically grown process relied on a **diamond engraving method with a bitumen-based coating**, which was later banned due to environmental regulations.

This meant the manufacturer had to reinvent their entire process.

Approach

- Introduction of the entire **PCM process** to Starrett
- Build a **cleanroom facility** for coating and imaging
- Develop a custom-made **dip-coater** that could handle **pre-etched, multi-dimensional steel parts** – up to 1 meter long

2nd case Dip-Coating Project

<u>The biggest technical challenges were:</u>

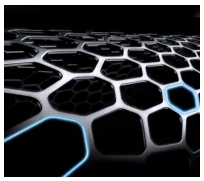
- Ensuring proper **adhesion on pre-structured surfaces**
- the **secondary coating** step – necessary when you need to layer resist over already-etched features to allow additional etching steps.

Results:

In the end, not only the banned process have been replaced - we delivered a solution that was **more precise, more stable, and eco-friendly**.

3rd case Dip-Coating Project

Precision nickel mesh foil for electric shavers



micro-structured **Electroforming part** that need to be **absolutely consistent**, as it impacts the shaving performance.

3rd case Dip-Coating Project

The problem:

- the previous process used **ammonium dichromate photo resist**, a **toxic and carcinogenic substance** that could no longer be used under EU regulations.

Challenges:

- *How to build a completely new, safe process – without compromising on product quality?*

Apporach:

- First, qualification of a **new, high-resolution resist** – using a **small dip-coater** with recipe management – built the basis to scale up if qualification is successful
- Second, Ensured the new resist had **strong adhesion**, **electrochemical resistance**, and **durability across repeated electroforming cycles**
- Third, Developed a **fully automated inline dip-coater** to allow coating of **10 large plates per cycle** under **Clean-room conditions**

3rd case Dip-Coating Project

Results:

- Professional in-line batch processing equipment
- A healthier, compliant process
- A fully scalable workflow
- no loss in performance

It's a great example of how to translate regulatory pressure into technological advantages.

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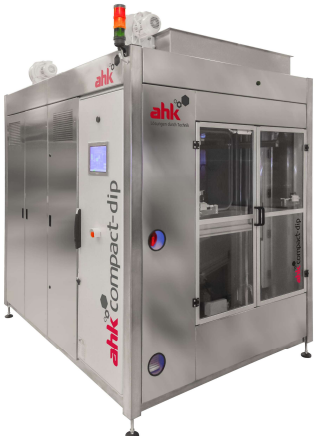
Learning Procter & Gamble

- This approach turned out as a common strategy to implement liquid photo-resist in a production process



Small dip-Coater

- **Medium throughput**
  Coats up to 24 substrates per hour
- **Compact and modular design**
- **Easy operation**

- **Professional Coating equipment**
- **Same basic features like the start-up kit, but higher throughput**
  Coats up to 100 substrates per hour

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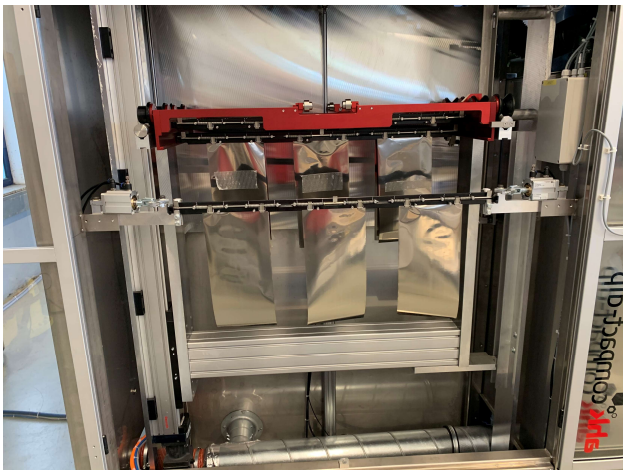
Best for very thin foils



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ahk Location

Where Technology meets…

…culture!

Graf Neipperg

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HiTech Photopolymere AG
Dr. David Schwärzle
Basel - Switzerland

Phone: +41 79 622 8379
www.htp.ch

ahk Service & Solutions GmbH
Andreas Harsch
Schwaigern - Germany

Phone: +49 177 513 77 26
www.ahk-service.de

Thank you very much for your attention!