Basic Photography in Phototooling

Idealine

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Elementary Photography

In Greek:

PHOTO = LIGHT
GRAFEIN = TO WRITE

PHOTOGRAPHY = WRITING WITH LIGHT
Elementary Photography

|-----------------------|-------------|------------|--------|------------------------|--------------|------------------------|------------|-------------|----------|

<table>
<thead>
<tr>
<th>U.V.</th>
<th>VISIBLE LIGHT</th>
<th>Near I.R.</th>
<th>Mid. I.R.</th>
</tr>
</thead>
<tbody>
<tr>
<td>200nm</td>
<td>400nm</td>
<td>600nm</td>
<td>800nm</td>
</tr>
</tbody>
</table>

**VISIBLE LIGHT**

![Visible Light Spectrum](image)
First law of chemistry

- Alkali + Acid $\rightarrow$ Salt + Water
- NaOH + HCl $\rightarrow$ NaCl + H$_2$O

Sodium hydroxide + hydrogen chloride

$\rightarrow$ sodium chloride + water
Silver Salts

- AgX
  - X = Cl, Br, I

- AgX is a weak compound
  - breaks easily down under the influence of energy
  - energy: temperature, pressure, chemicals, light, ...

- AgX + hν → Ag + X
  - Ag is metallic silver (black)
  - AgX can be dissolved in certain chemicals (fixer)
Photography

- Build AgX crystals (conglomerate of AgX compounds)
- Layer of AgX crystals on a plate
- Expose the plate to light (in camera, imager, plotter, ….)
  - AgX in exposed crystals turn to Ag + X
  - Non exposed crystals are unaffected
- Dissolve AgX crystals in a fixer
- Wash and dry
- Result: image

Some of these steps are far from ideal
Improvements: Developer

- Problem 1:
  - exposure takes several minutes

- Solution: amplification of the effect of light (developer)

- Principle:
  - crystals which were exposed have some Ag atoms
  - immerse in a chemistry that:
    - breaks down completely any AgX crystal starting at the Ag atom
    - crystals without Ag atoms remain unchanged
Improvements: Gelatine

● Problem 2:
  • when crystals touch one another the development goes on from crystal to crystal to crystal
  • the complete image turns black

● Solution: separate crystals in a matrix of gelatine
  • transparent
  • photographically inert
  • chemically inert
  • allow chemistry to penetrate
Improvement: Sensitiser

- **Problem 3:**
  - film is sensitive to all colors of light
  - film to be handled in absolute darkness

- **Solution: Sensitiser**
  - chemistry that captures light of a certain color
  - and passes the energy to a AgX compound that breaks down an Ag + X

- **Remark:** the AgX compounds themselves are made that un-sensitive that they do not to break down under normal light levels
Problem 4:
- Uneven light distribution
Image formation: sensitisers absorb light
Image formation: AgX splits
Improvement: Gold

- **Problem 5:**
  - Ag atoms are “mobile”
  - Ag atoms are hidden in the crystals
  - Chemistry can not reach them

- **Solution:** Gold at the outside of the crystals
  - A gold atom combines with 4 Ag atoms to form a stable nucleus
Image formation: Ag nucleus formation
Image formation: Ag nucleus formation
Problem 4: Uneven light distribution
Improvement: LIEC

- **Problem 4:**
  - Au atoms cannot access 4 Ag atoms

- **Solution: latent image enhancement component**
  - Chemistry that recovers single Ag atoms
    (LIEC Latent Image Enhancement component)
  - When activated by the developer the latent image enhancement component attracts “lost” Ag atoms
Image formation: development

All exposed crystals can be developed
Result: correct line width, highest line sharpness
Latent image enhancement component offers:

- Finest lines and spaces can be generated
- Highest line sharpness can be achieved
- Good line width control
  - The plotter controls the line width not the chemistry
- Wider exposure and development latitude
- RA-like chemistry
  - Highest stability
  - Lowest replenishment
Photography in phototooling: overview

- **Expose** (create latent image)
  - Sensitisers capture energy and pass to AgX underneath
  - The AgX underneath breaks into Ag and X
  - Ag and Au forms nucleuses

- **Processing**
  - Develop (turn latent image into visible one)
  - Latent image enhancement component assists development
  - Fix (dissolve unwanted crystals)
  - Wash (take out left over)
  - Dry

- **Acclimatise**
  - Absorb humidity from the environment
Structure of **Idealine**

- **matt**
- **antistress**
- **emulsion**
- **substrate**
- **substrate**
- **base**
- **substrate**
- **back**
- **matt**
Structure of Idealine

- Matting
- Antistress 1
- Antistress 2
- Emulsion
- Silver halide crystal 300nm
  1 million AgX-compounds / crystal
- Spectral sensitisers
- Gold atoms
- Adhesive layer 2
- Adhesive layer 1
- PET

Latent image enhancement components
## Structure of Idealine

<table>
<thead>
<tr>
<th>Layer</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matt</td>
<td>Control transport during loading and unloading</td>
</tr>
<tr>
<td></td>
<td>Control vacuum during printing</td>
</tr>
<tr>
<td>Antistress 1</td>
<td>Protect image from damage</td>
</tr>
<tr>
<td>Antistress 2</td>
<td>Protect image from damage</td>
</tr>
<tr>
<td>Emulsion</td>
<td>Image formation</td>
</tr>
<tr>
<td>Substrate 1</td>
<td>Bounding emulsion to substrate 1</td>
</tr>
<tr>
<td>Substrate 2</td>
<td>Bounding substrate 1 to base</td>
</tr>
<tr>
<td>Base</td>
<td>Mechanical support</td>
</tr>
<tr>
<td></td>
<td>Dimensional stability</td>
</tr>
<tr>
<td>Substrate 3</td>
<td>Bounding base to substrate 4</td>
</tr>
<tr>
<td>Substrate 4</td>
<td>Bounding substrate 3 to back layer</td>
</tr>
<tr>
<td></td>
<td>Antistatic properties</td>
</tr>
<tr>
<td>Back layer</td>
<td>Antihalation</td>
</tr>
<tr>
<td></td>
<td>Anti-curl</td>
</tr>
<tr>
<td>Matt</td>
<td>Control transport during loading and unloading</td>
</tr>
<tr>
<td></td>
<td>Control vacuum during plotting</td>
</tr>
<tr>
<td></td>
<td>Control vacuum during mounting on printer and printing</td>
</tr>
</tbody>
</table>
Structure of Idealine emulsion
Structure of Idealine: Cristals

Crystals: Oblique

Crystals: Perpendicular
Density

- The logarithmic value of the ratio of applied light over transmitted light

\[
X = 1\,000\,000, \quad Y = 10
\]

\[
\frac{X}{Y} = 100\,000 = 10^5
\]

Density = 5

\[
X = 1\,000\,0000, \quad Y = 900\,000
\]

\[
\frac{X}{Y} = 1.1 = 10^{0.05}
\]

Density = 0.05
Characteristic curve

- Relation between applied energy and density
Conclusions

- Photography is high tech
- Production tolerances are very narrow
- Many conflicting parameters, a film is a compromise
- Each application needs its specific film