Incode

Fraunhofer Institute for Manufacturing Engineering and Automation, Germany
Application of the tracing inks and detection of the images

- Within this project, more than 25 tracing inks, consisting of different binders and 28 IR additives, were evaluated for their IR-marking properties.
- The screening testing of the marking inks was performed for doctor blade applications on paper. The determination of the contrast values was performed using a FIR camera.
- For a selection of marking inks, the matrix codes were printed on paper and different textiles and decoding experiments were performed.
Contrast of the applied codes

maximum contrast

\[
\text{contrast value} = \frac{I \text{ (light section)} - I \text{ (dark section)}}{I \text{ (light section)} + I \text{ (dark section)}}
\]

contrast value: 4,0
**Screening of tracing inks with new IR additives for doctor blade applications on paper**

<table>
<thead>
<tr>
<th>Tracing ink No.</th>
<th>IR contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>0.04</td>
</tr>
<tr>
<td>9</td>
<td>0.54</td>
</tr>
<tr>
<td>10</td>
<td>0.09</td>
</tr>
<tr>
<td>14</td>
<td>0.15</td>
</tr>
<tr>
<td>15</td>
<td>0.07</td>
</tr>
<tr>
<td>16</td>
<td>0.01</td>
</tr>
</tbody>
</table>
Screening of tracing inks with new IR additives for doctor blade applications on paper

<table>
<thead>
<tr>
<th>Tracing ink No.</th>
<th>IR contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>0,22</td>
</tr>
<tr>
<td>12</td>
<td>0,79</td>
</tr>
<tr>
<td>13</td>
<td>0,06</td>
</tr>
<tr>
<td>17</td>
<td>0,11</td>
</tr>
<tr>
<td>18</td>
<td>0,19</td>
</tr>
</tbody>
</table>
Screening of tracing inks with new IR additives for doctor blade applications on paper

<table>
<thead>
<tr>
<th>Tracing ink No.</th>
<th>IR contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>0.02</td>
</tr>
<tr>
<td>20</td>
<td>0.04</td>
</tr>
<tr>
<td>21</td>
<td>0.22</td>
</tr>
<tr>
<td>22</td>
<td>1.13</td>
</tr>
<tr>
<td>23</td>
<td>1.37</td>
</tr>
</tbody>
</table>
Screening of tracing inks with new IR additives for doctor blade applications on paper

<table>
<thead>
<tr>
<th>Tracing ink No.</th>
<th>IR contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>1.37</td>
</tr>
<tr>
<td>25</td>
<td>0.22</td>
</tr>
</tbody>
</table>
Properties of the printed matrix codes
## Color difference (DE*) of printed matrix codes on paper

<table>
<thead>
<tr>
<th>Tracing ink No.</th>
<th>DE* / D65</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>1,327</td>
</tr>
<tr>
<td>9</td>
<td>1,102</td>
</tr>
<tr>
<td>10</td>
<td>2,518</td>
</tr>
<tr>
<td>11</td>
<td>4,323</td>
</tr>
<tr>
<td>12</td>
<td>3,558</td>
</tr>
<tr>
<td>13</td>
<td>8,029</td>
</tr>
<tr>
<td>14</td>
<td>1,020</td>
</tr>
<tr>
<td>15</td>
<td>2,961</td>
</tr>
<tr>
<td>16</td>
<td>0,921</td>
</tr>
<tr>
<td>17</td>
<td>1,306</td>
</tr>
<tr>
<td>18</td>
<td>1,241</td>
</tr>
<tr>
<td>19</td>
<td>1,094</td>
</tr>
<tr>
<td>20</td>
<td>1,206</td>
</tr>
<tr>
<td>21</td>
<td>2,554</td>
</tr>
<tr>
<td>22</td>
<td>2,198</td>
</tr>
<tr>
<td>23</td>
<td>3,554</td>
</tr>
<tr>
<td>24</td>
<td>3,556</td>
</tr>
<tr>
<td>25</td>
<td>3,618</td>
</tr>
</tbody>
</table>
Printing of matrix codes on paper
IR contrast of matrix codes on paper

Tracing ink No.8; overprints / OP

<table>
<thead>
<tr>
<th>OP</th>
<th>IR contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0,00</td>
</tr>
<tr>
<td>2</td>
<td>0,00</td>
</tr>
<tr>
<td>3</td>
<td>0,04</td>
</tr>
</tbody>
</table>

Tracing ink No.9; overprints / OP

<table>
<thead>
<tr>
<th>OP</th>
<th>IR contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0,18</td>
</tr>
<tr>
<td>2</td>
<td>0,22</td>
</tr>
<tr>
<td>3</td>
<td>0,19</td>
</tr>
</tbody>
</table>
IR contrast of printed matrix codes on paper

<table>
<thead>
<tr>
<th>Tracing ink No.10; overprints / OP</th>
<th>IR contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 OP</td>
<td>0,00</td>
</tr>
<tr>
<td>2 OP</td>
<td>0,09</td>
</tr>
<tr>
<td>3 OP</td>
<td>0,10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tracing ink No.15; overprints / OP</th>
<th>IR contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 OP</td>
<td>0,00</td>
</tr>
<tr>
<td>2 OP</td>
<td>0,00</td>
</tr>
<tr>
<td>3 OP</td>
<td>0,00</td>
</tr>
</tbody>
</table>
IR contrast of printed matrix codes on paper

<table>
<thead>
<tr>
<th>Tracing ink No.11; overprints / OP</th>
<th>IR contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 OP</td>
<td>0.05</td>
</tr>
<tr>
<td>2 OP</td>
<td>0.16</td>
</tr>
<tr>
<td>3 OP</td>
<td>0.15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tracing ink No.12; overprints / OP</th>
<th>IR contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 OP</td>
<td>0.22</td>
</tr>
<tr>
<td>2 OP</td>
<td>0.34</td>
</tr>
<tr>
<td>3 OP</td>
<td>0.58</td>
</tr>
</tbody>
</table>
IR contrast of printed matrix codes on paper

<table>
<thead>
<tr>
<th>Tracing ink No.13; overprints / OP</th>
<th>IR contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 OP</td>
<td>0.00</td>
</tr>
<tr>
<td>2 OP</td>
<td>0.04</td>
</tr>
<tr>
<td>3 OP</td>
<td>0.15</td>
</tr>
</tbody>
</table>
Tracing ink 12 printed with three overprints on different substrates

- Cotton
- Plastic Film
- Conex
- PA6
- PES eco
Measurement setup for the detection of 2D matrix codes

- IR camera
- NIR flood light
- Textile sample with inkjet printed 2D code
- IR video
## Selection of printed matrix codes with different IR contrasts on paper

<table>
<thead>
<tr>
<th>Tracing ink / OP</th>
<th>Contrast</th>
<th>decodable with software from</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>AT</td>
</tr>
<tr>
<td>Ink 9 / 1 OP</td>
<td>0.18</td>
<td>☹️</td>
</tr>
<tr>
<td>Ink 9 / 2 OP</td>
<td>0.22</td>
<td>☹️</td>
</tr>
<tr>
<td>Ink 9 / 3 OP</td>
<td>0.19</td>
<td>☹️</td>
</tr>
<tr>
<td>Ink 12 / 1 OP</td>
<td>0.22</td>
<td>☹️</td>
</tr>
<tr>
<td>Ink 12 / 2 OP</td>
<td>0.34</td>
<td>☹️</td>
</tr>
<tr>
<td>Ink 12 / 3 OP</td>
<td>0.58</td>
<td>☻️</td>
</tr>
</tbody>
</table>
Our aim are code detections like these…
Summary

• The tracing ink formulation, which is optimized on the decoding properties, was given to the partner institutes for application and testing on different substrates.

• Tracing ink formulations containing new IR additves were developed.

• Tracing ink 12 gives a good IR contrast, which can be decoded, if the appropriate software is used.

Follow-up

• Optimization of marking inks referring to IR contrast and fastness properties.

• Improvement of decoding process.