Technology and Applications of Microstructured Pigments

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Microstructured flakes

Optically Active Microstructures.
  i.e. Gratings
Different Frequencies and Linear, cross, sinusoidal, blazed, etc. grooves

Combination of:
- Gratings
- Shapes
- Symbols
- Others

Inserted Symbols/Logos
Number of symbols, size, etc

Shapes
Diamond, Rectangular, etc

Multifunctional single or multilayer.
Thin Film Interference, Magnetic, Other functionalities
Pigment Manufacturing Technology

Embosed PET Substrate

Vacuum deposition

e⁻ Gun

Separation

- Grinding
- Classification
- Blending

Pigment flakes
Dispersion of Light by a Grating

Normal Incidence

White Incident light

-1\textsuperscript{st} order

1\textsuperscript{st} order

Zero order

d = 0.714 \text{m}\mu

85° Incidence

White Incident light

-1\textsuperscript{st} order

-2\textsuperscript{nd} order
Decorative Silver Diffractive Pigments.
Diffractive Pigments blends with Non-Shifter Pigments

Silver Diffractive with Organic Pigments
Microstructured Pigments

3 Layer Design. MgF$_2$ / Al / MgF$_2$

High frequency

Flat surface

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High Frequency Microstructure

Diffraction only for high angle illumination

Incident light

High angle illumination
Opaque Optical Designs

Black diffractive
5 layer: Cr/Spacer/Al/Spacer/Cr
Based on Thin film Interference
Thin, Low or High index, spacer

Bronze diffractive
3 layers: ZnS/Copper/ZnS
Based on Intrinsic Absorption of Cu

Red none shifter diffractive
5 layers: Cr/High index/Al/High index/Cr
Based on Thin film Interference.
High index spacer
Diffractive & Thin Film Interference

Thin film Interference

Stronger visual effects when seen at near specular reflection (metallic character).

Diffractive Interference

Metallic coloration when seen in diffuse light conditions and strong iridescent diffractive effects when seen in direct illumination.
Rd-Go none-Diffractive and Diffractive pigments

Diffuse Illumination
Direct Illumination

Rd-Go none-Diffractive and Diffractive pigments

Incident light

None-Diffractive

Diffuse reflection

Specular reflection

Incident light

Diffractive

None

Diffractive pigments
All Dielectric Diffractive Pigments

If TiO$_2$/SiO$_2$ → Skin contact friendly

“White” Diffractive Pigment

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Anti-counterfeit Solutions

• Layered solutions for increased security
  
  – Overt features
    • Designed to be recognized as a security item
    • Majority of counterfeits or tampering easily detectable
  
  – Covert features
    • Complement strong overt features
    • Forensic properties
## Requirements for Anti-counterfeiting Devices

<table>
<thead>
<tr>
<th>Overt Features</th>
<th>Covert Features</th>
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<tbody>
<tr>
<td>- Easy to verify because specific visual effects.</td>
<td>- Easy to verify with simple detection devices.</td>
</tr>
<tr>
<td>- Hard to copy. Use restricted materials and/or technology.</td>
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<td>- Hard to duplicate or simulate with other commonly available materials and/or technologies.</td>
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<td>- Compatible with final application</td>
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<tr>
<td>- Preferably visually attractive</td>
<td>- Non visually detectable</td>
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<td></td>
<td>- Preferably provide Field and Forensic Detection Options.</td>
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COMBINING TECHNOLOGIES

Diffractive Magnetic Pigments

+ Printing under Magnetic fields
Magnetic Orientation of Particles

Shape anisotropy

The long axis is the “Easy Axis” of orientation

2D Compass needle

3D Ellipsoidal shape

For a flake
Surface anisotropy

The “Easy Axis” of orientation is along the grooves
Diffractive Optical Variable Device

White Illumination Beam

Bright Diffractive beam.

Dark area

25 micron

90° rotation

500 l/mm

1400 l/mm
Tilting the device

90° grooves orientation between areas when rotated

Magnetic Diffractive 3000 l/mm + Red dye
Microstructured Covert Taggants

Shaped flakes
Symboled flakes
Combination of microstructures
Diamond Shaped Flakes
Layering Technologies

Magnetic Diffractive Gr-BI 150 l/mm + GeoEuros
Layering Technologies

Combination of a Demetalized Hologram, Optical Variable Pigment and Personalized Covert Taggants

Microstructured covert flakes

Stamped security device on a poker ship
Conclusions

-The combination of materials with different optical and magnetic properties with selected microstructures have generated a whole new family of special effect pigments for the decorative, security and authentication markets.

-New devices need to be constantly develop as barrier to counterfeiting.

-Layering multiples technologies in a single device is an efficient way to prevent counterfeiting
Thanks for your attention

Questions?