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SMART COLOR

Nanotechnology & Packaging

Food contact and food related sensoric materials

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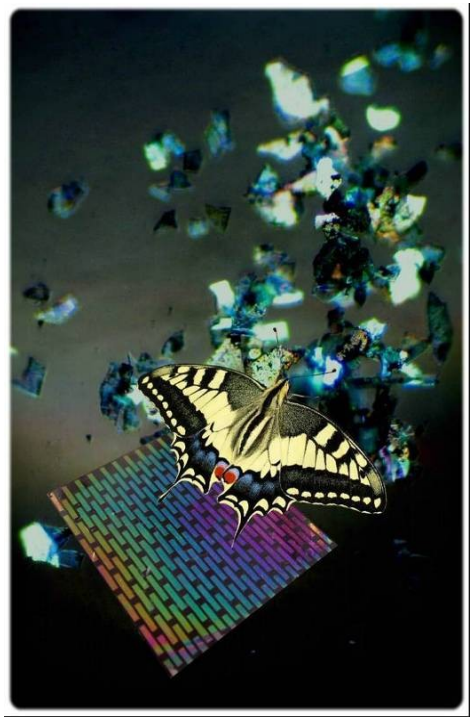
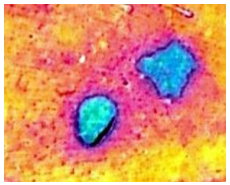
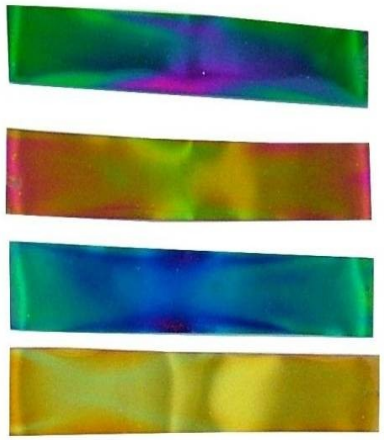


5 Videos not included

Possible uses for paper & packaging?

- Hydrophobization of paper and board
- Coloration
  - Adsorption of dyes on nanoparticles
  - Nanoparticles as colorants
- Retention aids
  - Microparticle → nanoparticle systems
- Printability
  - e.g. laser, inkjet, offset printing
- Improved barrier properties
  - e.g. nano-clay
- Intelligent packaging
  - e.g. smart pigments



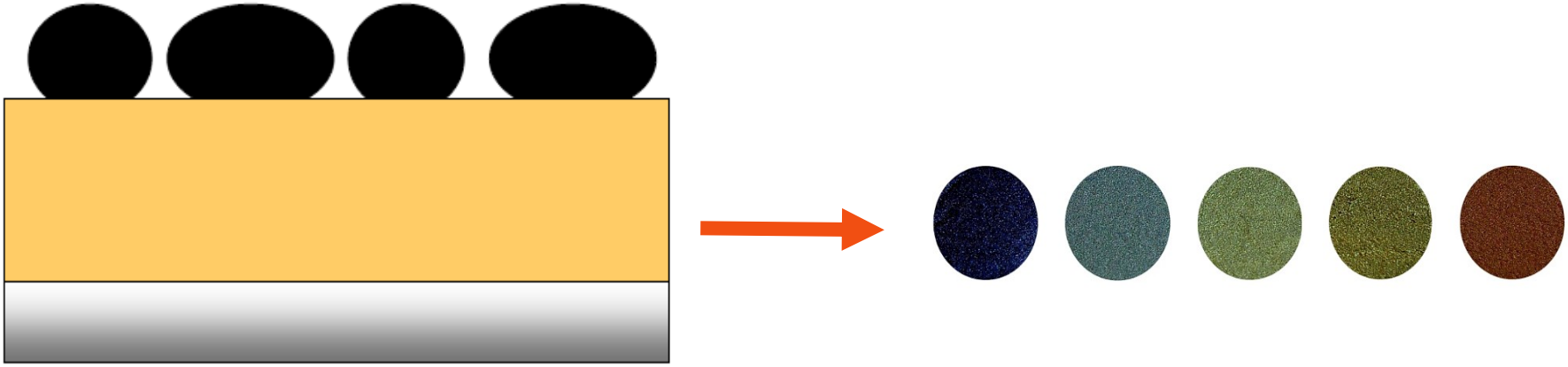


Smart colors

Smart colors are based on Resonance Enhanced Absorption

All smart-color systems consist of three layers:

- mirror bottom layer (e.g. metal or material with a high refractive index)
- color & sensor layer (e.g. chemo-reactive polymer)
- resonant counter-layer on top of middle layer



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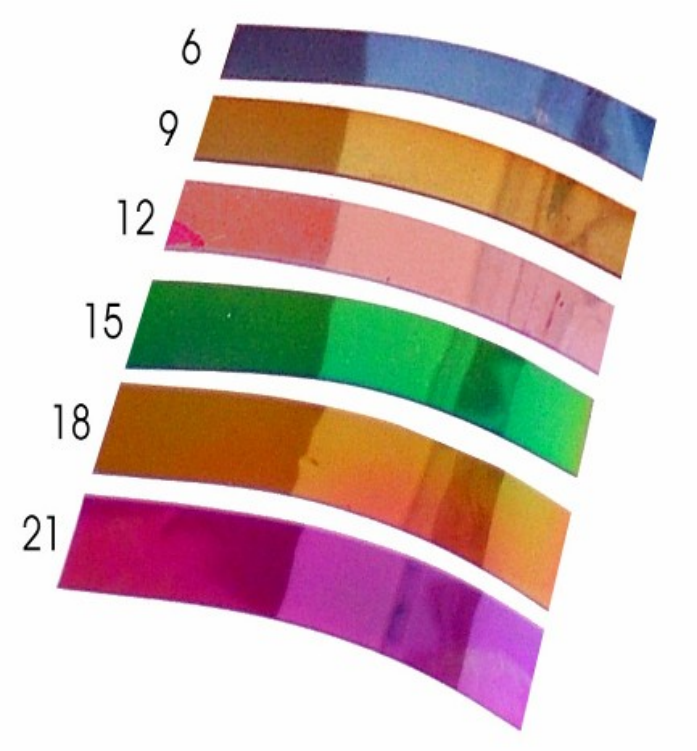
What are smart pigments?

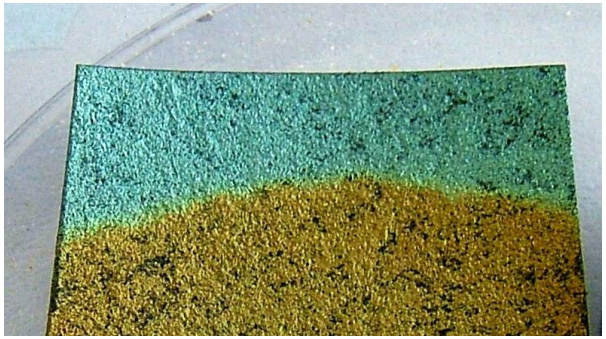
A novel technology to transform nano-structural changes into variable color

- Tunable color
- Applicable/printable on any surface
- Multi-color same-chemistry
- Stable versus bleaching
- Nano “material use” -> resources
- Smart metallic layout
- Less to non-toxic
- Machine readable
- Extreme thermal robustness
- Can be combined with barcode and labels



Where are smart pigments ?

- Novel colors for printing
- Indicators
- Anti-counterfeiting
- Corporate Identity
- Pharma packaging
- Intelligent packaging
- Cosmetics
- Design
- Jewellery
- Pigments for ….



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Color is a function of structure – not of chemistry !!

e.g. layer thickness, refractive index,...

Options:

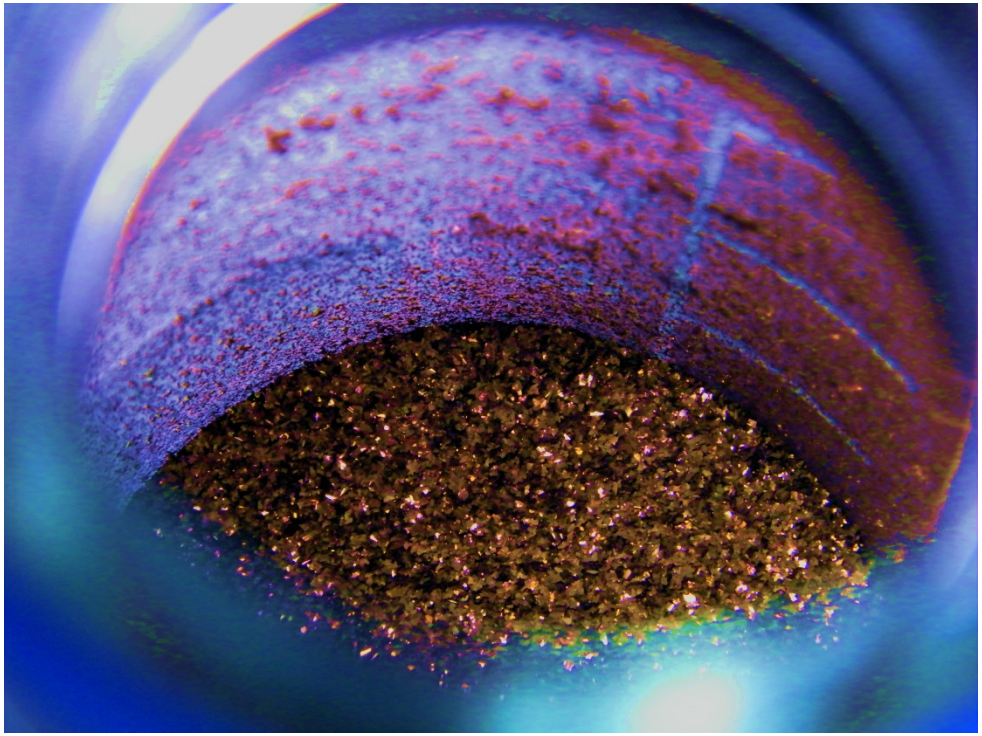
1.) vary number of clusters (1998)

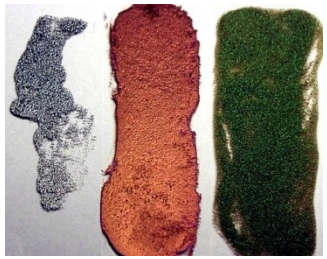
2.) vary cluster-mirror distance (1994)

3.) use laser for color (2007)

4.) use pigments for smart inks (2007)

5.) reactive films (2009)





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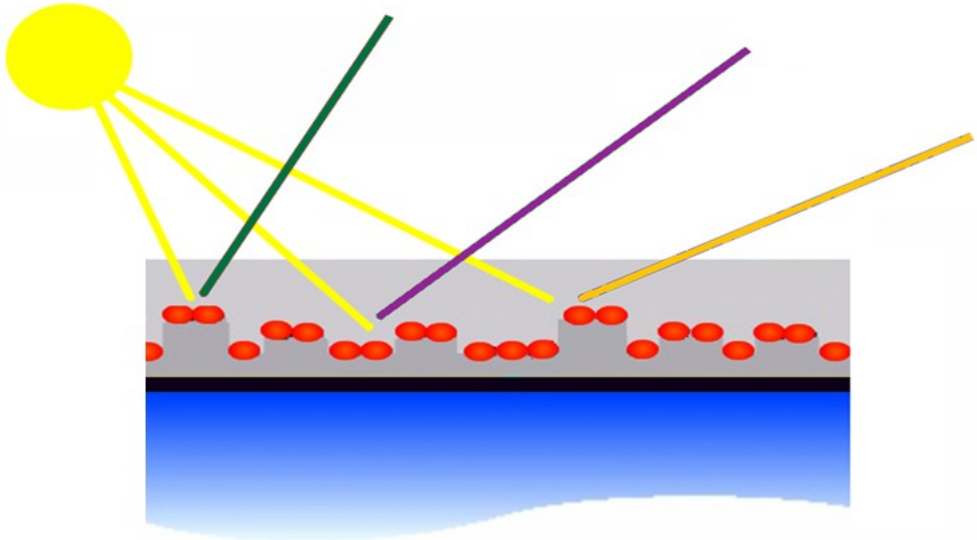
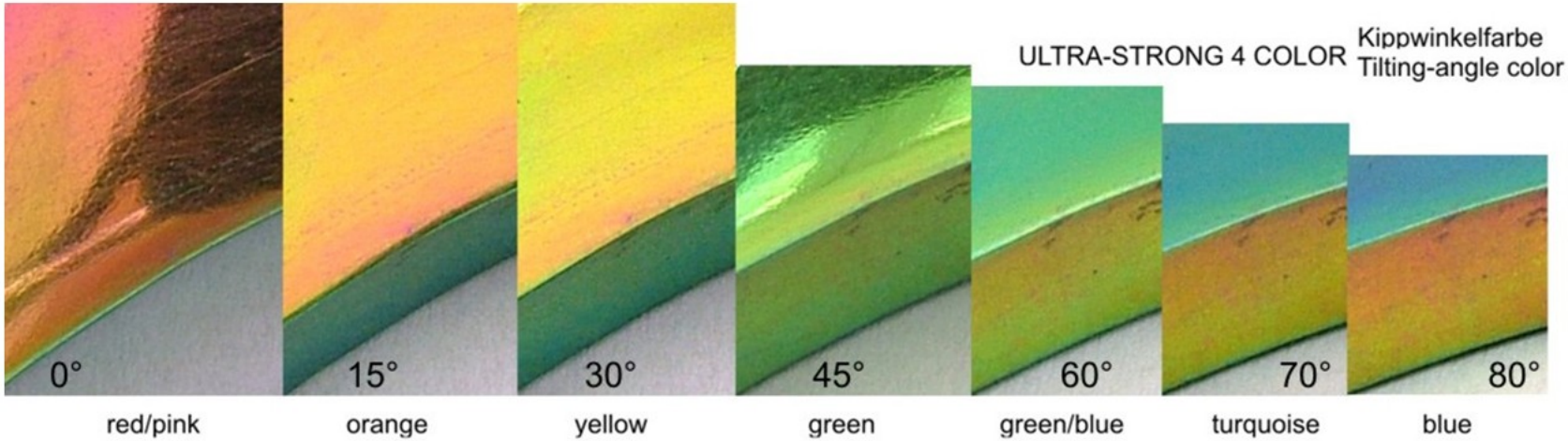
Structure of smart pigments

Viewing angle dependent color





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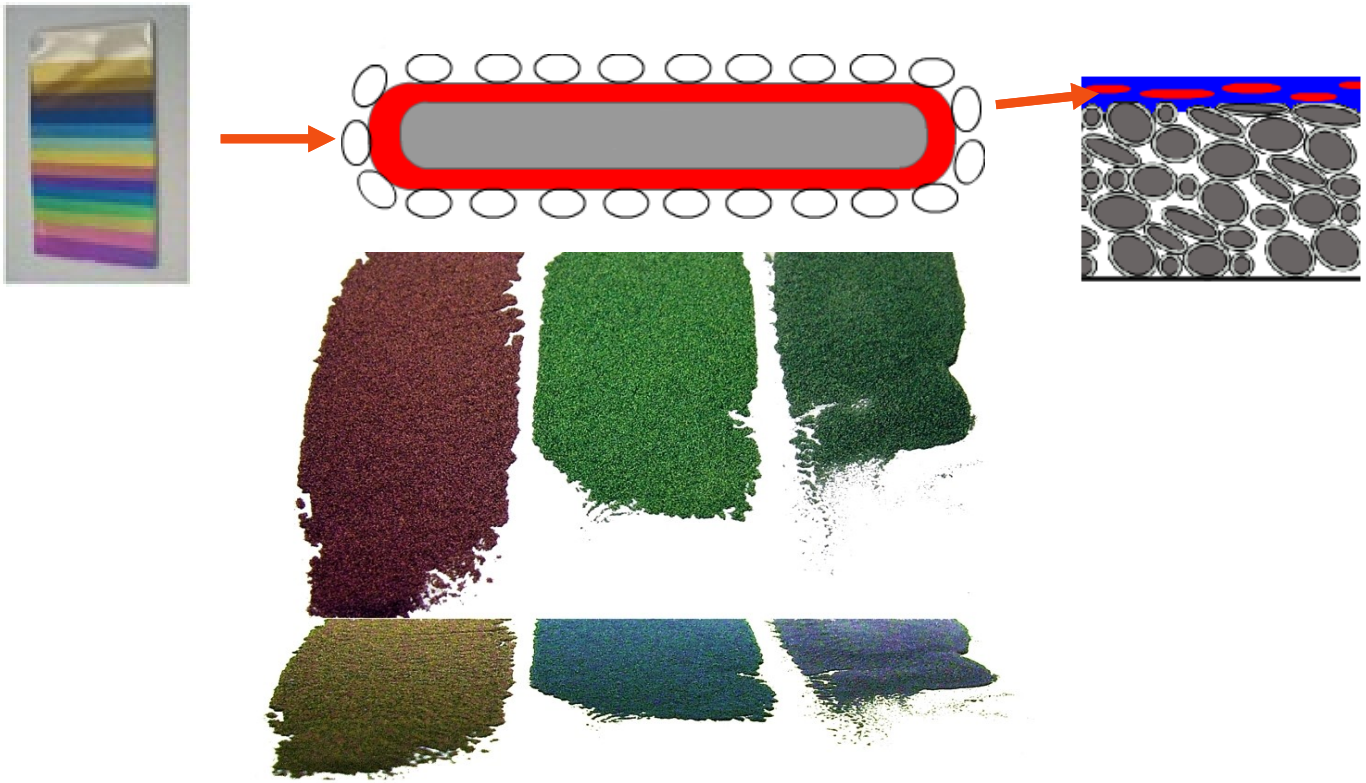
From smart layers to smart pigments



Thermal stability up to 600° C

Smart pigments for humidity indication

- In 1998 the EC issued a directive which classifies Co(II) chloride used for these indicators as T (Toxic) and R49 (may cause cancer if inhaled).
- As a consequence new cobalt-free humidity indicator cards have been developed by some companies based on Copper (II) chloride - not carcinogenic but still using a toxic metal.
- Smart humidity indicators (SHIs) are next generation products based on nano-structural changes and thus free of heavy or toxic metals and free of soluble metal salts.

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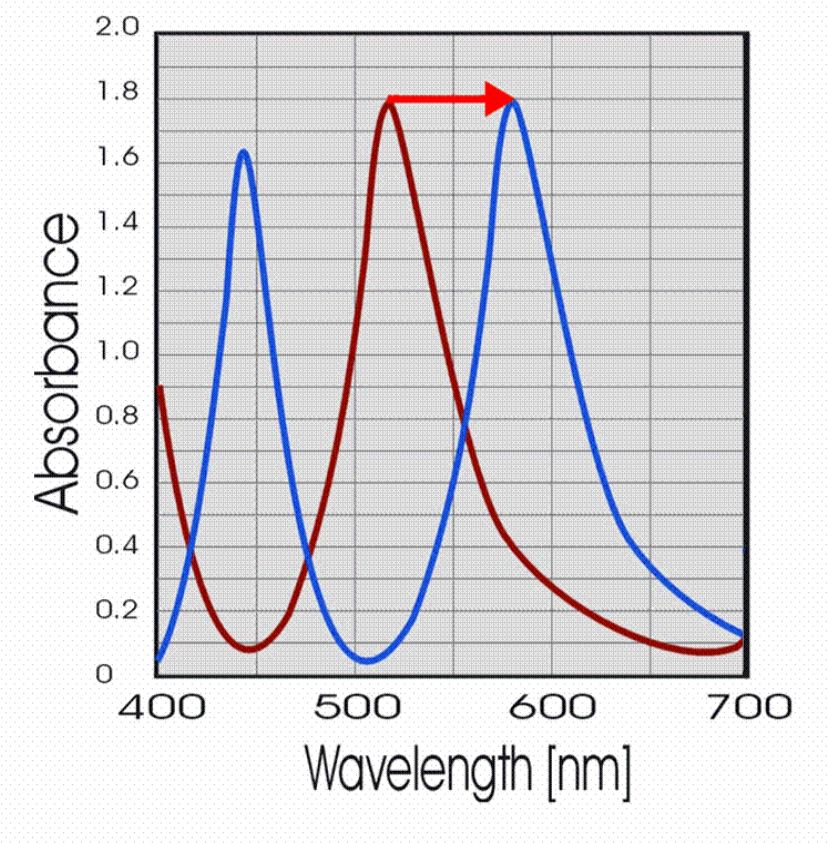
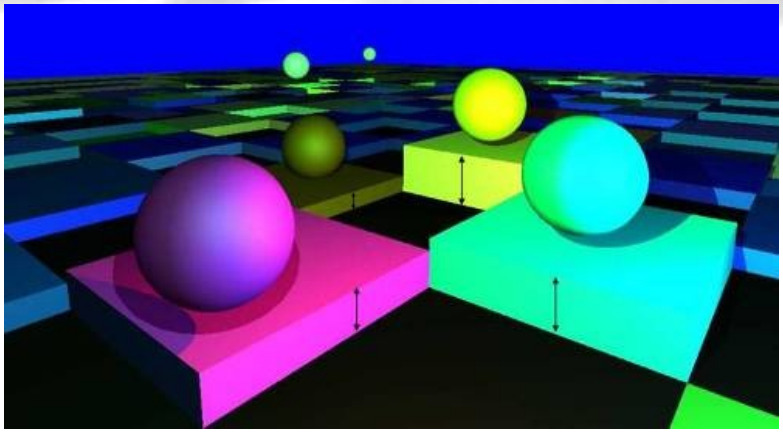
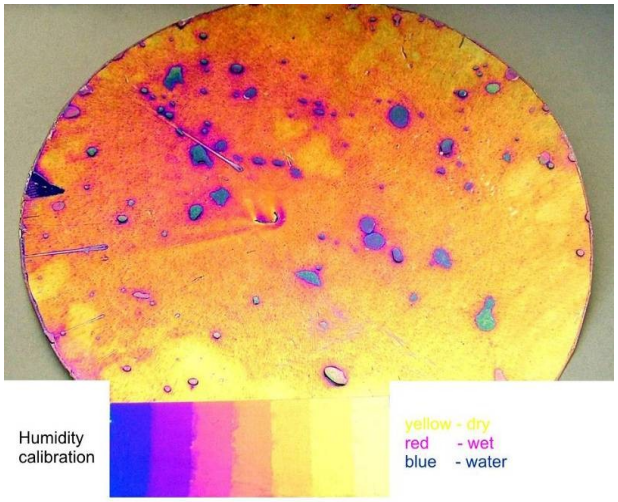
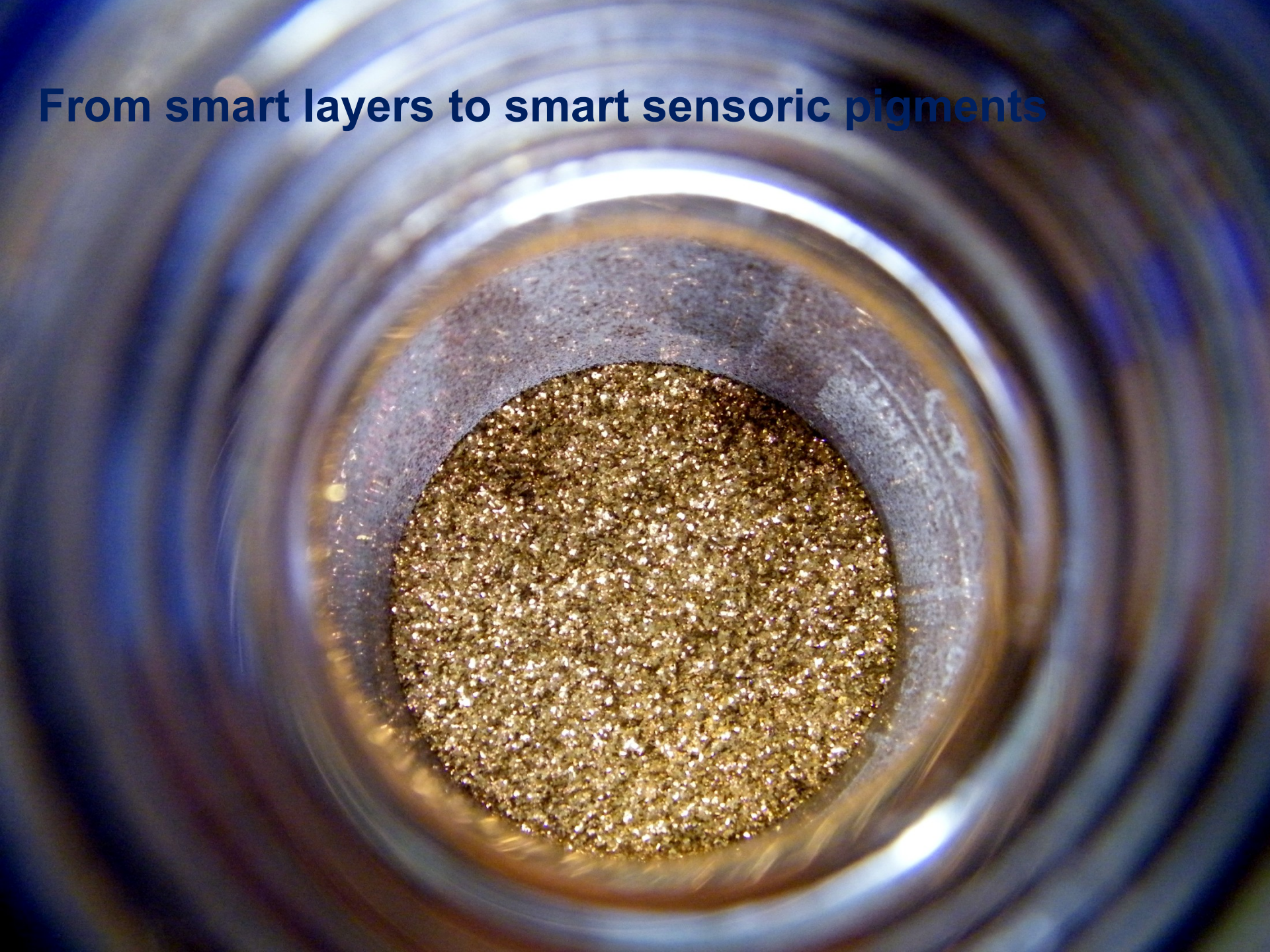
Smart pigments for humidity indication







From smart layers to smart sensoric pigments



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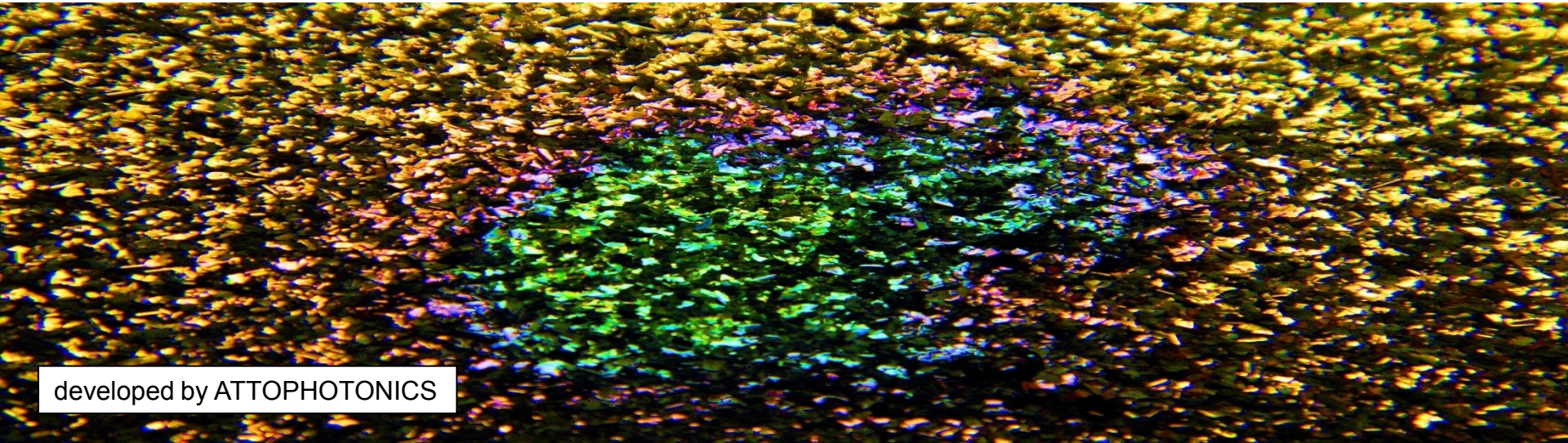
Smart pigments for humidity indication

Setup

- mirror bottom layer (e.g. metal or material with a high refractive index)
- middle layer (humidity-reactive polymer)
- resonant counter-layer on top



Smart pigments for humidity indication

- SHIs are unique nano-materials with a moisture-sensitive nano-structure - not a chemical!
- usually embedded in a polymer coating matrix
- such that it will change color e.g. when the indicated relative humidity is exceeded
- inexpensive way to quantify relative humidity levels inside sealed packaging
- available in many configurations, colors and combinations and used in many applications, including food, packaging, bulk goods and semiconductor industry
- maximum humidity indicators are specially designed to monitor relative humidity (RH) levels in cargo applications

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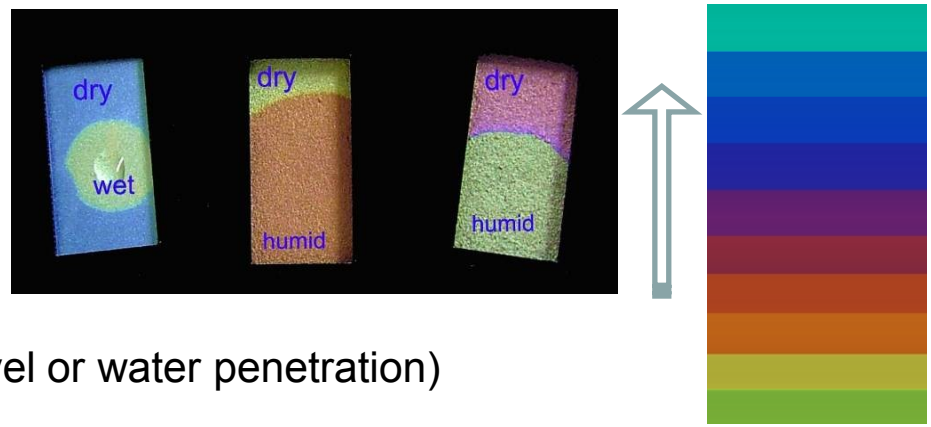
Smart pigments for humidity indication

- SHIs can change color from
  - blue to green
  - from green via yellow to red
  - from red to green (indicating RH level or water penetration)



- High humidity coupled with poor packaging methods is causing most corrosion of metals as well as moisture damage to food products.

- An industry wide standard for packaging of semiconductors was released already in 1989. SHIs for the semiconductor industry indicate RH-levels of 5, 10 and 15 % and since JSTD-033B in 2005 require indication of 5, 10 and 60 %.

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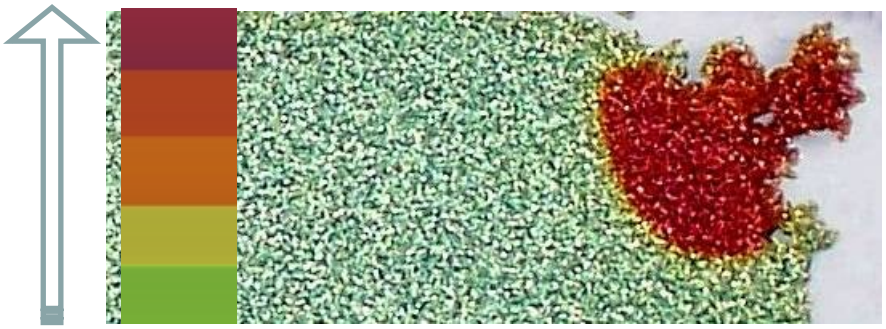

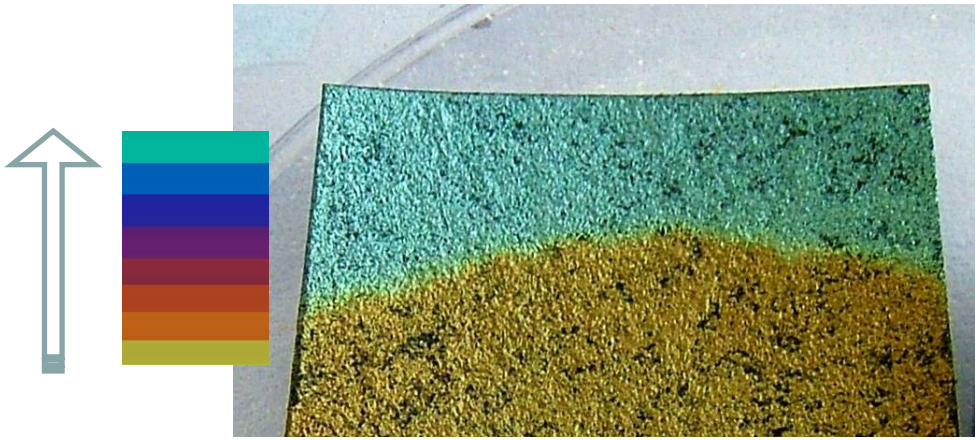

SHI-pigments printed on paper

wet green
dry yellow

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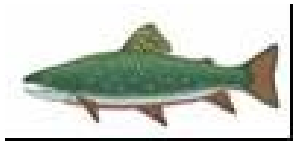
Smart pigments for food status indication

…for fish, meat,

poultry spoilage,..



…for butter indicating souring

…for milk packages indicating spoilage

…and devices for cooling chain,

sweet drinks, baby-food,

vegetables in glass & canned food…

…convenience food, microwave heating,..

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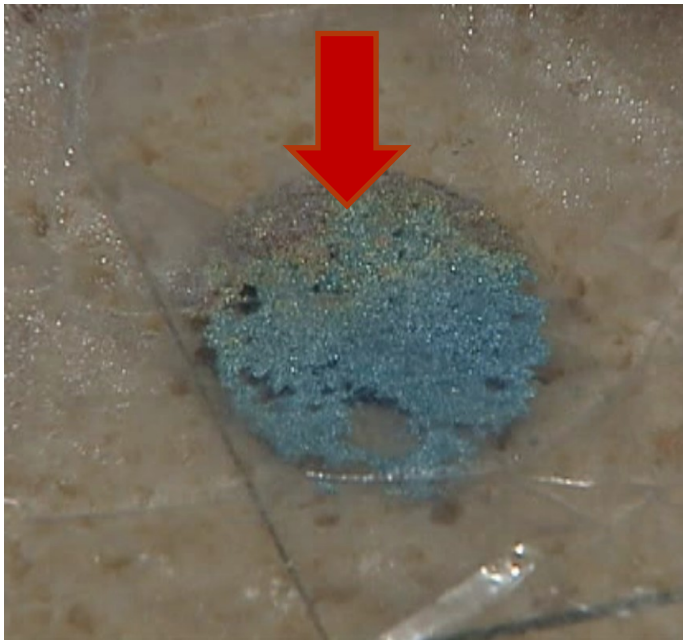
Smart pigments for food status indication

Microbial contamination of fish



Usage of SHIs for humidity control in food packaging

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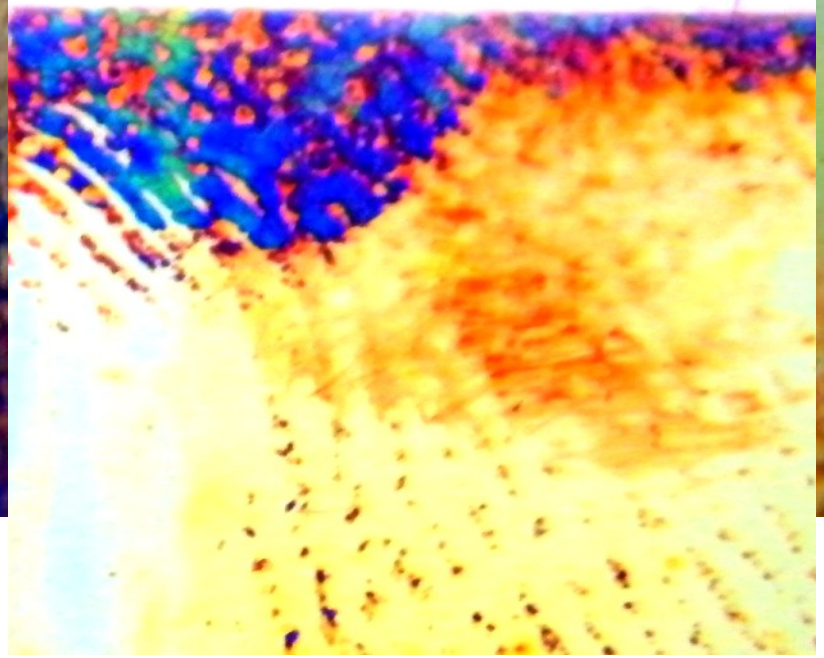
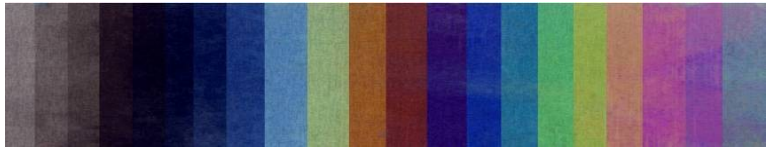
Finger print indicator films



Summary

- Color change can be triggered by any chemical or physical stimulus
- Wide range of different colors
- Minimum material for maximum effect
- Intelligent material which can be used for
  - Indicators (packaging, pharmaceutical, medical, technical applications)
  - Design (jewellery, surface finishing, etc.)
  - New printing technologies
  - …



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