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Functional coatings with strong colours prepared by magnetron sputtering

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MIICS
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Outlook

- identif GmbH: company profile
- Nano Colour Coatings (NCC)
  - a) basic setup
  - b) description of generation of colour
  - c) influence of process parameters on optical properties
  - d) combination of decorative features with functionality
- Examples of functional coatings
- Conclusion

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identif GmbH Company Profile

identif GmbH

- subsidiary of november AG
- independent company since 31.12.2003
- strong patent portfolio
- ISO 9001 certificated
- highly qualified staff (60% R&D)

business divisions:

- security engineering partnership with DUPONT exclusive worldwide marketing and sales
- coating technology sales partnership with AVALUXE INTERNATIONAL

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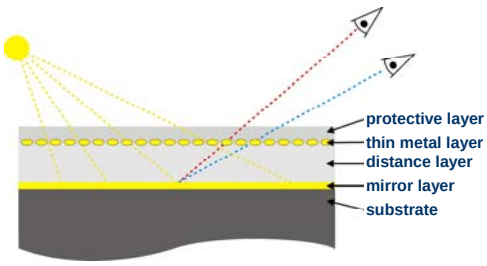
Nano Colour Coatings – what are they?

Nano Colour Coatings
- are prepared by magnetron sputtering
- can be applied on to different materials (metal, glass, plastics,...)
- consist of the following setup:



Colour generation is based on **Fabry-Perot effect** and **Surface Enhanced Absorption**

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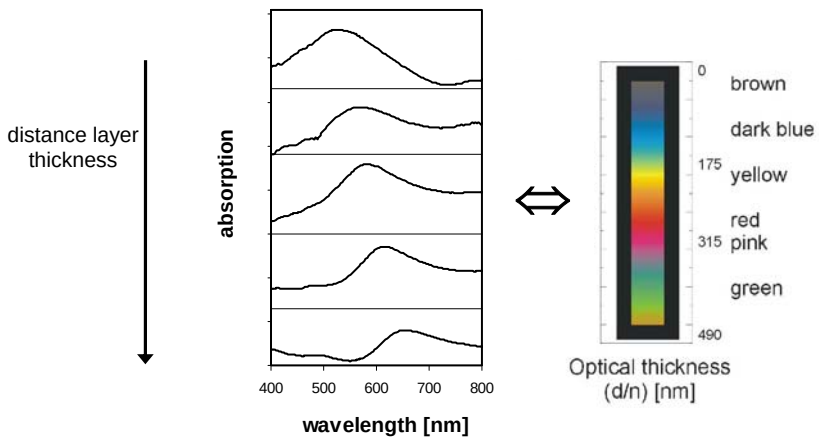
Distance layer thickness ⇔ Resulting colour



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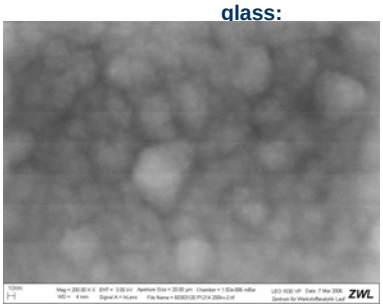
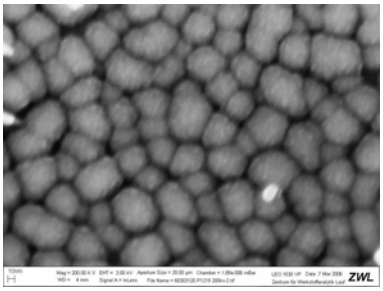
Thin metal layer: morphology ⇔ *Optical properties*

Adjusted process parameter settings ⇒ differences in morphology.

SEM analyses of thin Ag- films on glass:



bulk film



cluster film

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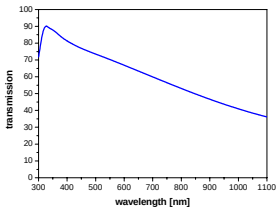
Thin metal layer: morphology ⇒ optical properties

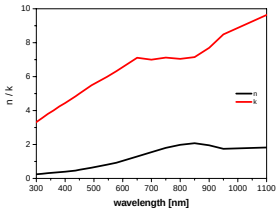
Ag layer, 9 nm

Transmission spectra

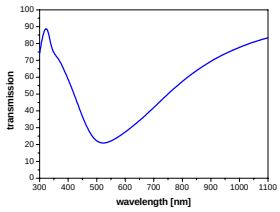
Optical constants (n, k)

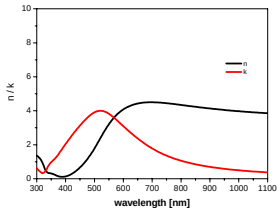
bulk film





cluster film





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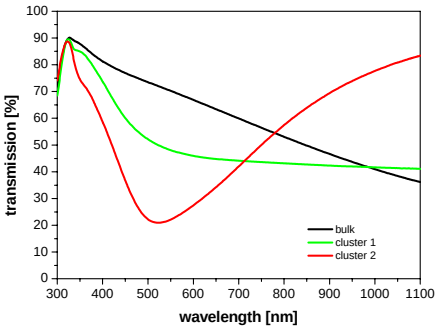
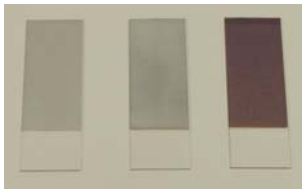
Thin metal layer

Control of cluster formation by variation of the process parameters:





bulk **cluster 1** **cluster 2**

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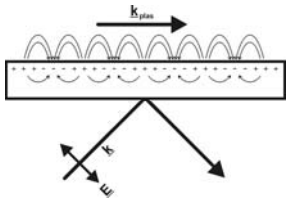
SEA: Surface plasmons

bulk layer



free electron gas

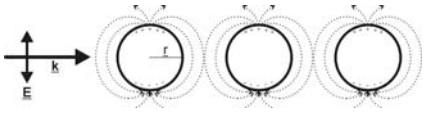
$$\varepsilon(\sigma,\lambda) = 1 - \frac{ne^2 / m\varepsilon_0}{(2\pi c/\lambda)^2 + i\frac{ne^2}{m\sigma(\lambda)}(2\pi c/\lambda)}$$

confined electron gas

$$\varepsilon_2(Q,\sigma,\lambda) = \frac{9n_{sub}^2 c}{\sigma(1-Q)^2}\frac{Q\lambda^3}{\left(\lambda_{\max}^2 - \lambda^2\right)^2 + \frac{\lambda^2\lambda_{\max}^4 c^2}{4\lambda_c^4\sigma^2}}$$

$$\lambda_{\max}^2 \sim \frac{2+Q}{1-Q} \qquad r << \lambda$$

cluster layer



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Nano Colour Coatings(NCC) Setup: “functional coatings”

- NCC setup: mirror, distance layer, thin metal layer, protective topcoat
- A broad range of different materials (metals, oxides, nitrides, oxynitrides, etc.) can be applied for generation of colours
- Selection of suitable materials for specific requirements:
  - thermal stability
  - Electrical conductivity
  - Mechanical and / or chemical resistance

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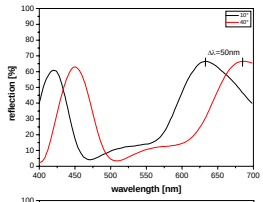
NCC Setup: Influence of distance layer

- “thickness”: on resulting colour
- “optical properties”: on strength of colour shift

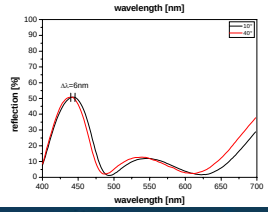
strong shift:

0° 60°



weak shift:

0° 60°



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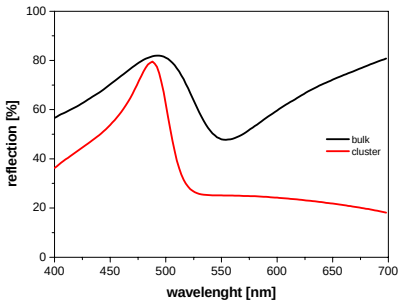
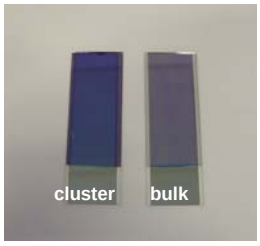
NCC- Setup Influence of thin metal layer

Influence on optical spectrum:

- **intensity of colour (thickness)**
- **reflection / absorption properties (morphology)**





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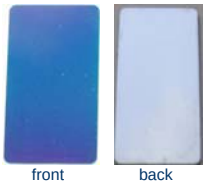
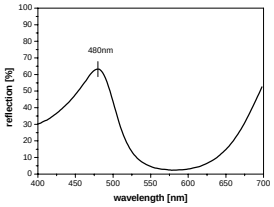
Functional coatings: example I

Thermal stability: Setup on polished steel plates

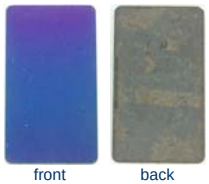
after depositon



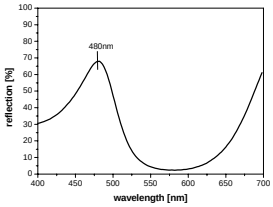
front back



annealed at 650°C for 1 hour



front back



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Functional coatings: example II

electrical and mechanical properties: coated chip card modules

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Functional coatings: example III

forgery-proof and stable: bearings (FAG)

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Functional coatings: example IV

Decorative and tear resistant: coated braceletts and drills

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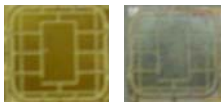
Functional Coatings: example V

“Anti-fingerprint”

Integration of a “fingerprint”- layer into NCC setup

Enhancement or **prevention**



of fingerprints

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Conclusion

- **NCC consists of a mirror, distance layer, thin metal layer and a protective top coat**
- **A broad range of colours and colour effects can be created on divers substrates (metal, glass, plastics, etc.)**
- **Absorption, reflection (and transmission) properties can be tailor fitted to requirements**
- **Colours can be combined with desired functional properties**

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Thank you for your attention!

Thanks to the NCC team at identif:

Dr. Georg Bauer (managing director identif)

Mathias Belzner

Sandra Genov

Robert Friedel

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