TANN GROUP

Mechanically Generated Surface Structures on Tipping Paper and their Effects on Haptic and Visual Characteristics

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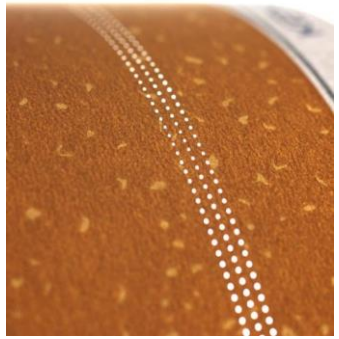
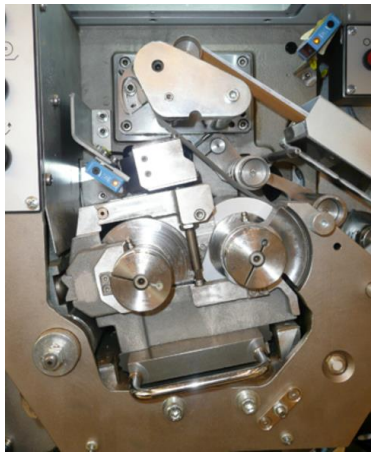
MAIN FEATURES OF TIPPING PAPER

- Relevant component for combustible filter cigarettes and heated tobacco products (HTPs)
- Connection of the tobacco rod with the filter plug
- Perforation for specific filter ventilation and smoke yields
- Brand characterization via printing, hotfoil stamping, etc.
- Carrier for special substances (e. g. flavors)

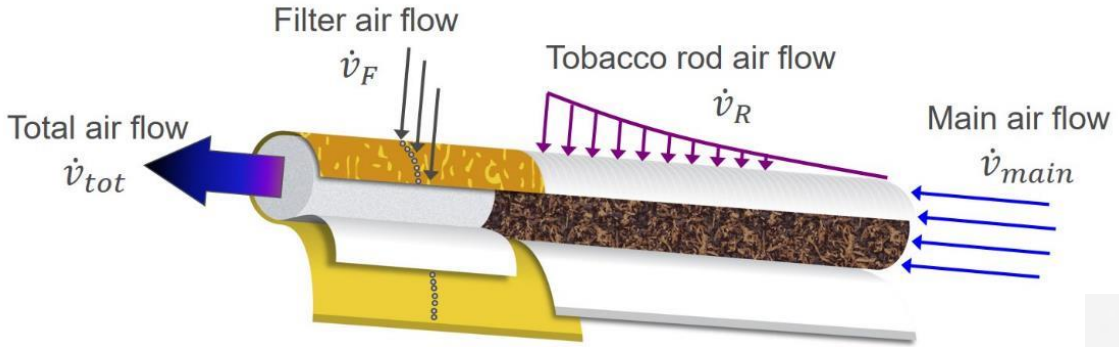


PHYSICS OF TIPPING PAPER

- Absorption properties for the
  - gluing process
  - printing quality
  - lip-release efficiency



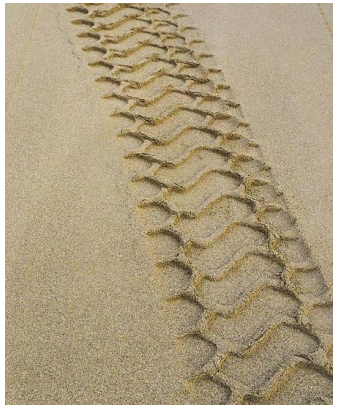
- Permeability for the control of smoke dilution

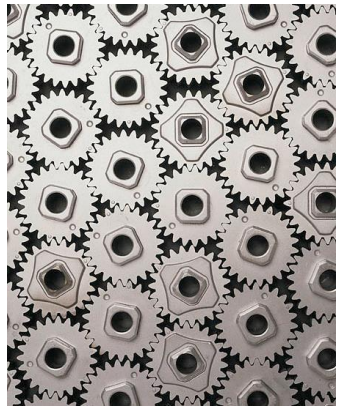


- Mechanical parameters, e. g. grammage, thickness, smoothness, tensile strength and elongation for the performance during cigarette / HTP making

PHYSICAL TREATMENT OF TIPPING PAPER

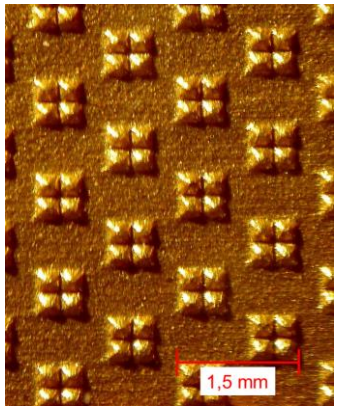
- Mechanical embossing to create surface structures on the substrate
- Physical process only = no extra chemical treatment of the material = no conflicts with sensory and ingredients assessments
- Generation of interaction between the tobacco product and the consumer through haptic and visual surface characteristics
- Three levels of embossing – depending on the size of the created reliefs: **Macro-, micro- and nano-embossing**

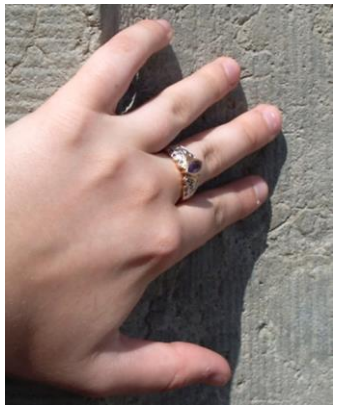


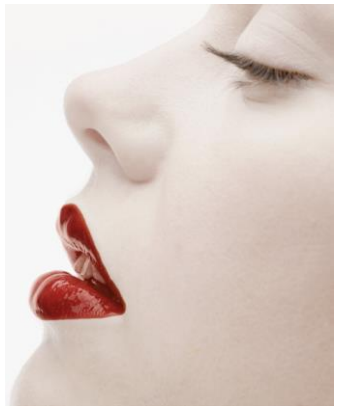


PART I: MACRO-EMBOSSING

- Web material is guided between surface textured rollers → embossing height = 15 µm – 80 µm depending on the substrate
- Human haptic sensitivity starts at structure dimensions of approx. 20 µm
- Definition: Haptic perception = active exploration of surfaces
- Haptic interaction with the consumers‘ lips and fingers





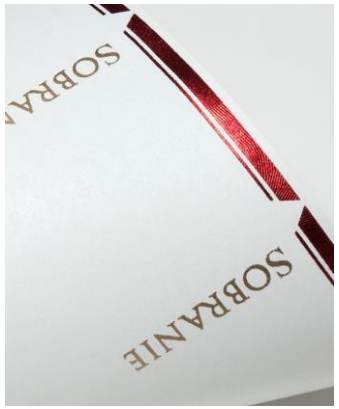


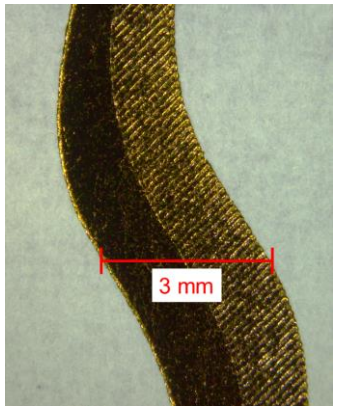
MACRO-EMBOSSING: FEATURES

- “What you see is what you feel” concept = imitation of textiles or natural materials
- Applicable under restrictive regulations (potentially “plain packaging” markets)
- Implementation as security feature for anti-counterfeit activities
- Enhanced lip-release effect due to less effective contact area between the human lips and the paper surface

PART II: MICRO-EMBOSSING

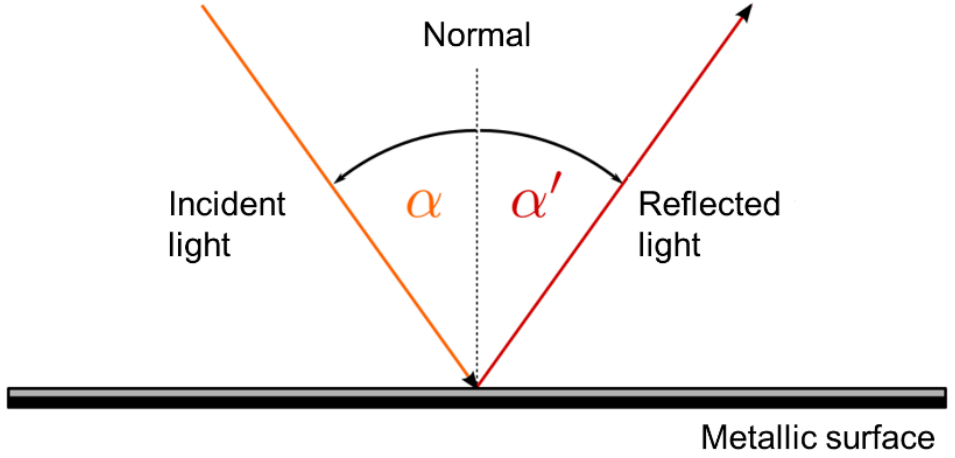
- Finishing technique on hotfoil stamping or other metallic surface items
- Embossing structures are created within a range below 10 µm → no haptic impact!
- Visual interaction with the consumer due to changing play of light and colors depending on viewing angle
- Effect is based on the physics of light reflection and scattering

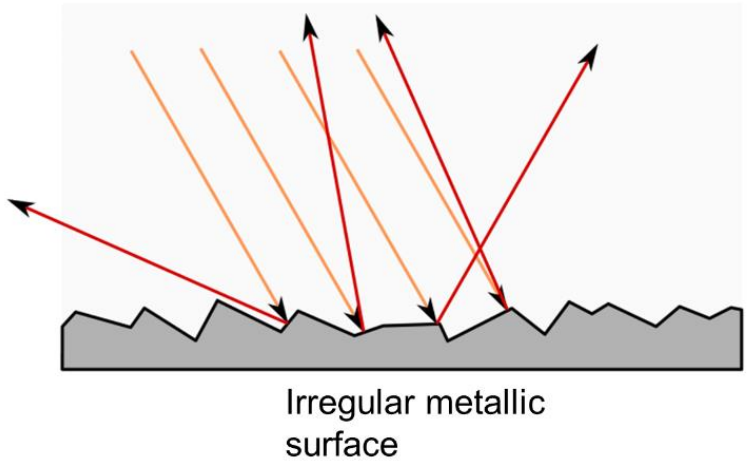




THE PHYSICS OF MICRO-EMBOSSING

- Reflection of light (combination of regular & diffuse reflection):
  - Regular reflection: The angle of incidence equals the angle of reflection ($\alpha = \alpha'$)
  - Diffuse reflection: Multiple reflections by the microscopic irregularities of the surface

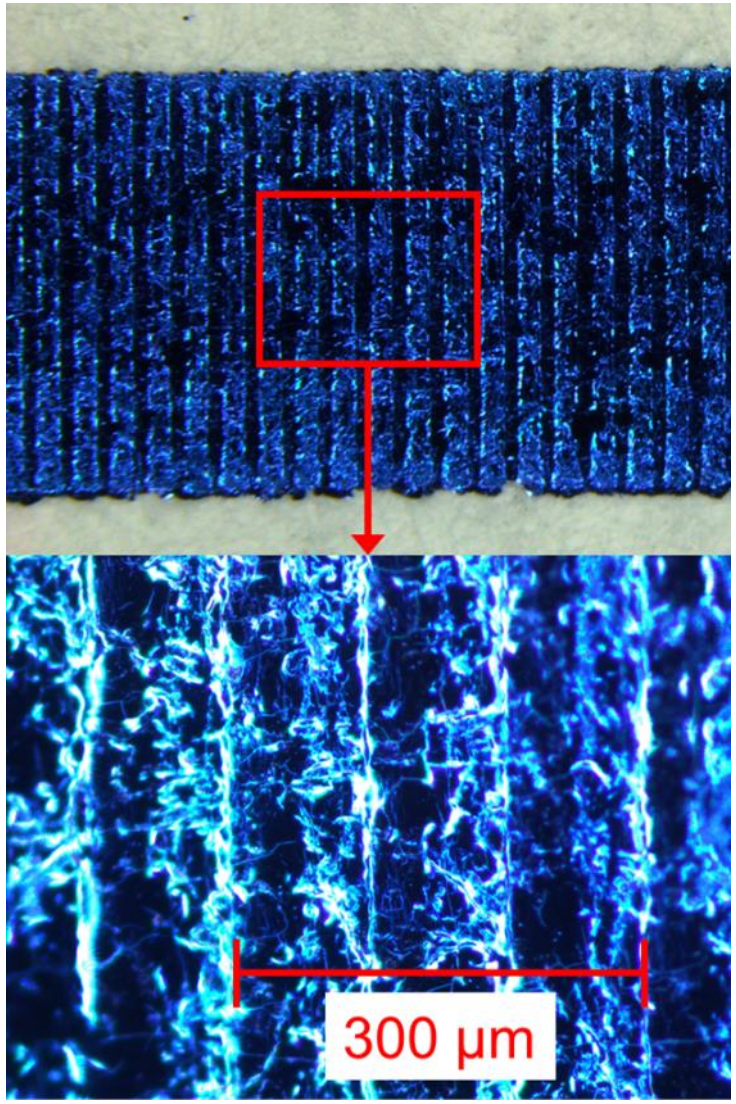




- Micro-embossing comprises both types of reflection (shiny & matt)

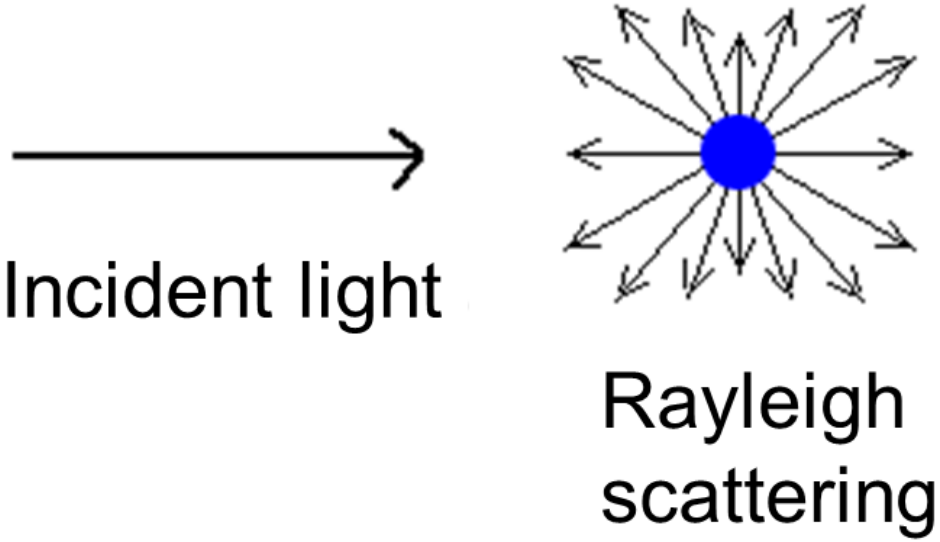
THE PHYSICS OF MICRO-EMBOSSING

- Scattering of light: Deviation from a straight propagation of light by local non-uniformities, i. e. roughness of the surface on a nanoscopic scale



THE PHYSICS OF MICRO-EMBOSSING

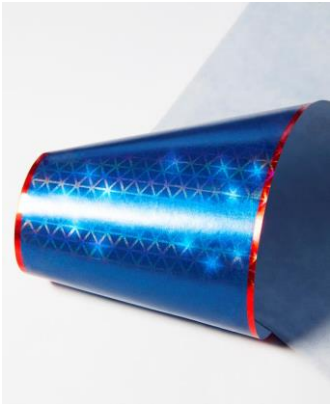
- Scattering of light: Deviation from a straight propagation of light by local non-uniformities, i. e. roughness of the surface on a nanoscopic scale
  - Rayleigh scattering: Elastic scattering of light by the non-uniform metallic surface
  - Intensity I of scattering depends on the light‘s wavelength λ:
  - This scattering effect creates the observed color-shift phenomenon of micro-embossing

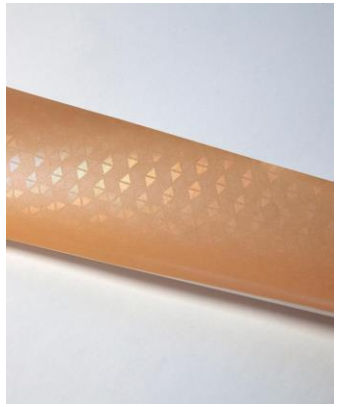


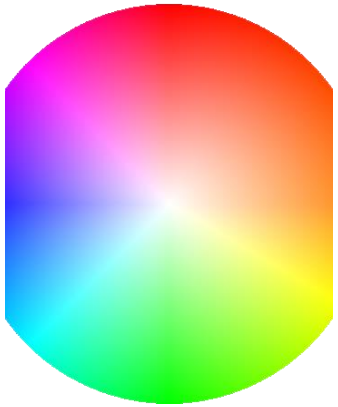
$$I \propto \frac{1}{\lambda^4}$$

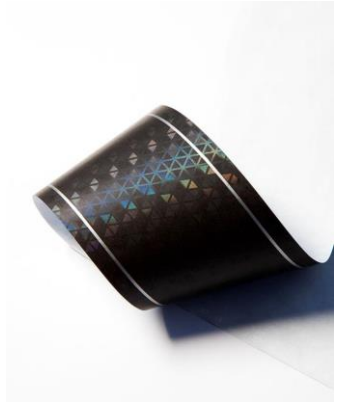
PART III: NANO-EMBOSSING

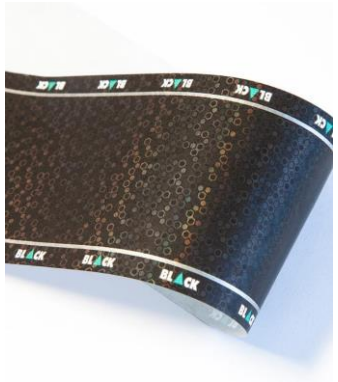
- Application of nano-embossing technology on Tipping Paper
- Nano-structures are subjected to optical diffraction and interference:
  - Visible light is split into its spectrum of colors
  - Changing play of colors depending on viewing angle
  - Rainbow, holographic and tilted image visual impressions





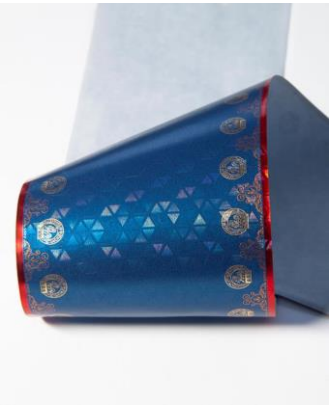


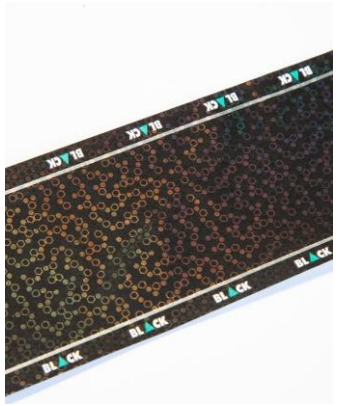




NANO-EMBOSSING: FEATURES

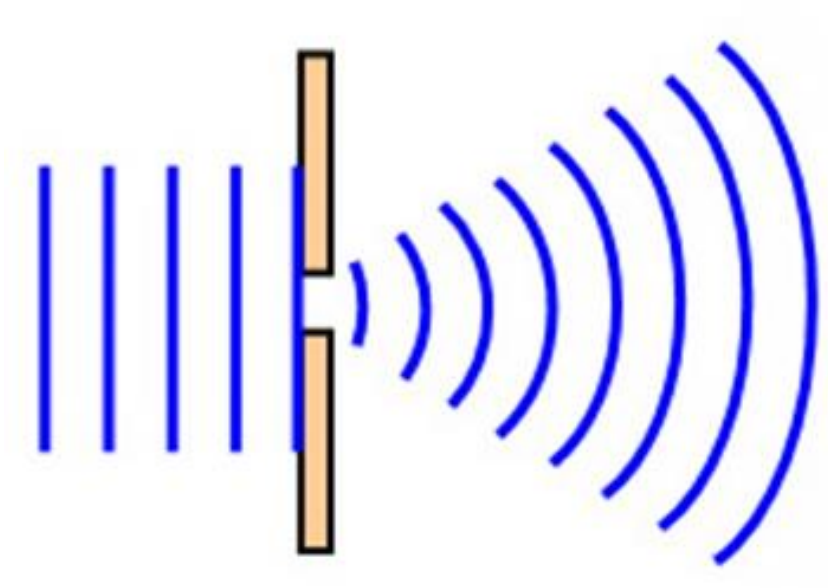
- Clear differentiation from standard products = increased brand recognition
- Potential and high-level security feature for anti-counterfeiting – not only for Tipping Paper, but also applicable to tobacco product packaging
- Sustainability aspect: Realization of holographic effects without using specific metallic foils or plastic films





THE PHYSICS OF NANO-EMBOSSING

- Optical diffraction: Bending of light waves around the corners of an obstacle into the region of the geometrical shadow of the obstacle



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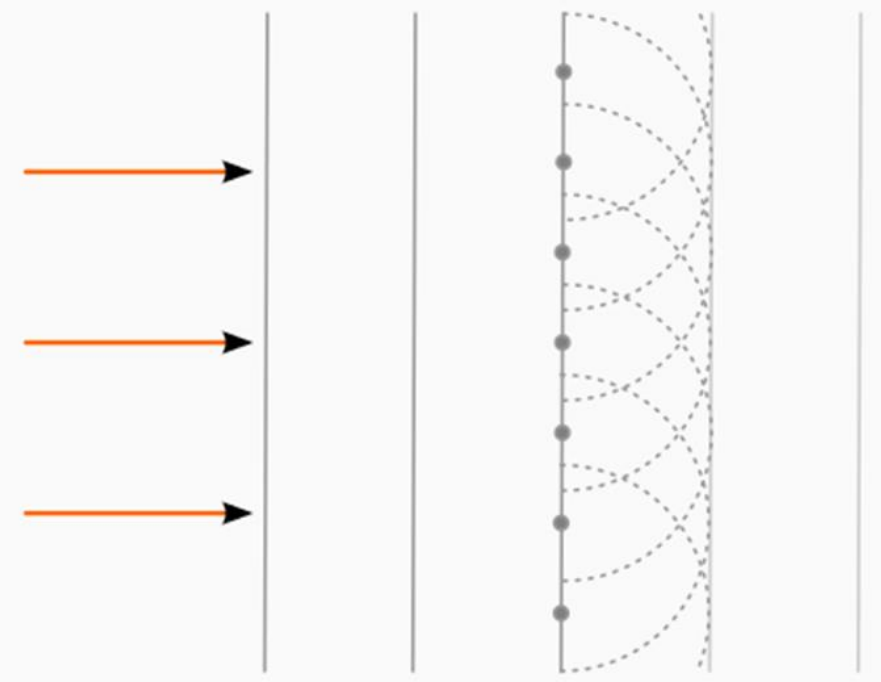
  - The diffracting object becomes a secondary source of the propagating wave
  - The size of the diffracting object is comparable with the wavelength



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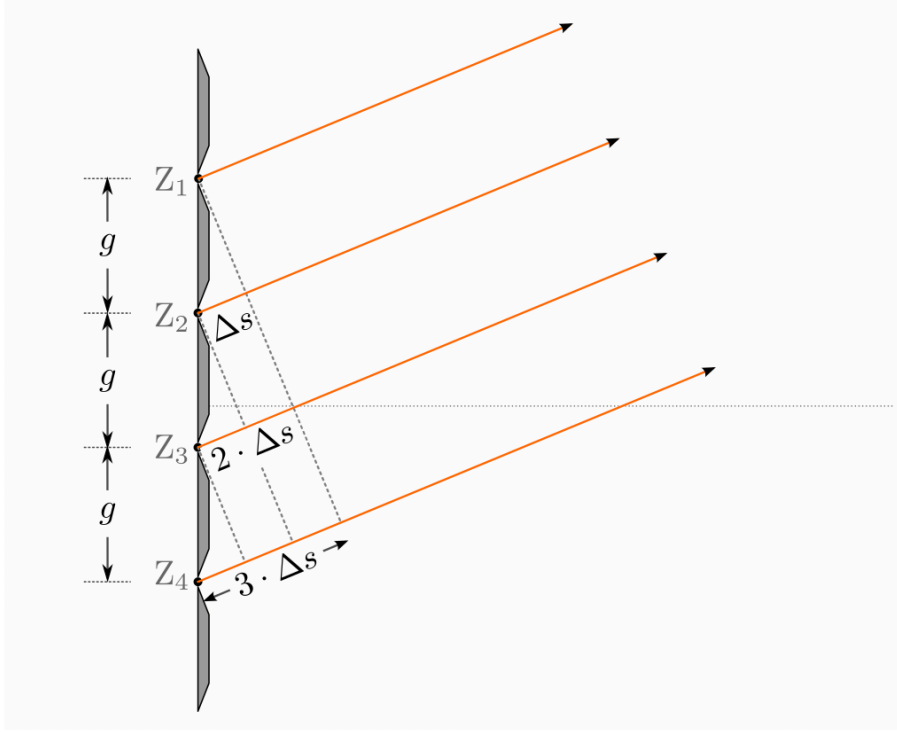
  - Nano-embossing acts as diffraction grating = optical component with a periodic structure causing light beams travelling in different directions



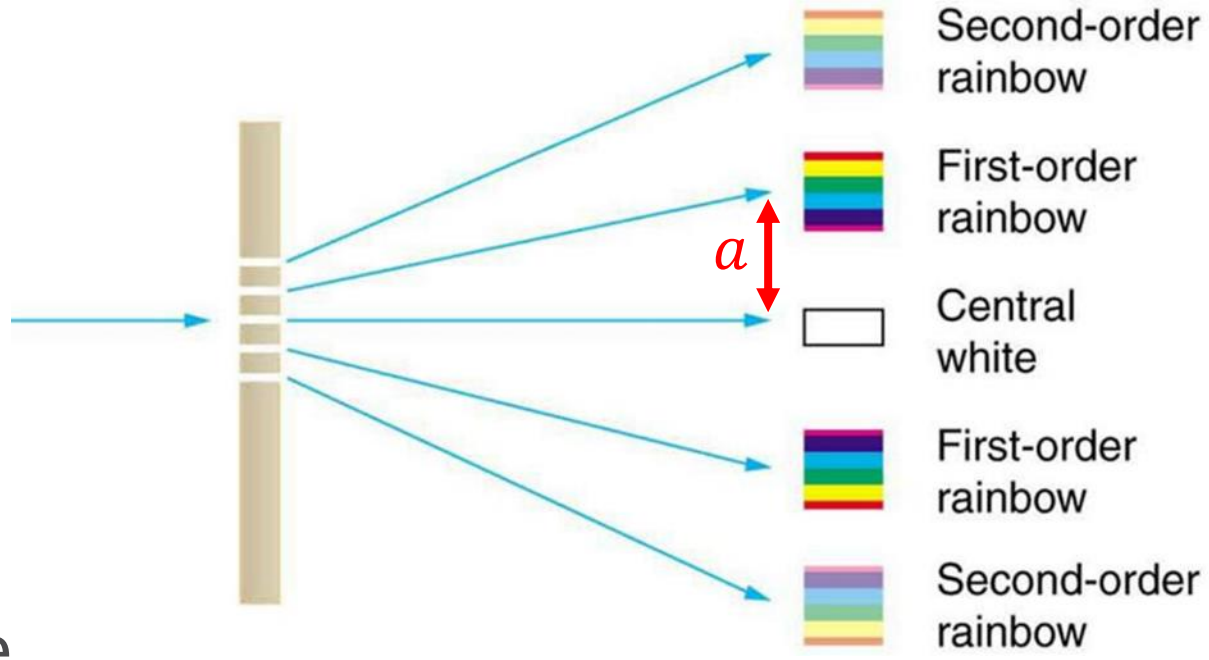
g… spacing between the slits
Δ*s*… path difference

THE PHYSICS OF NANO-EMBOSSING

- Optical interference: Based on the result of optical diffraction
  - Diffraction grating serves as dispersive element
  - Emerging coloration is a form of structural coloration
  - Distance a between the interfering beams depends on the wavelength λ:

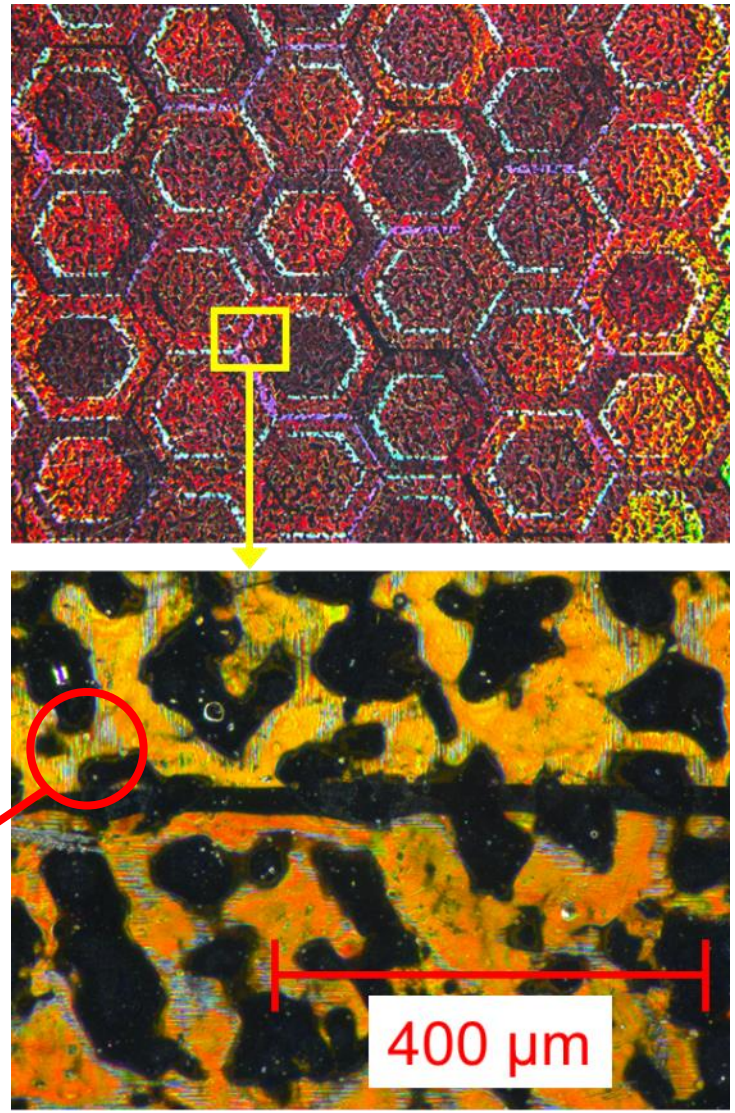
$$a = \frac{k \cdot s}{g} \cdot \lambda$$

k… diffraction order
s… distance between grating and screen / eyes



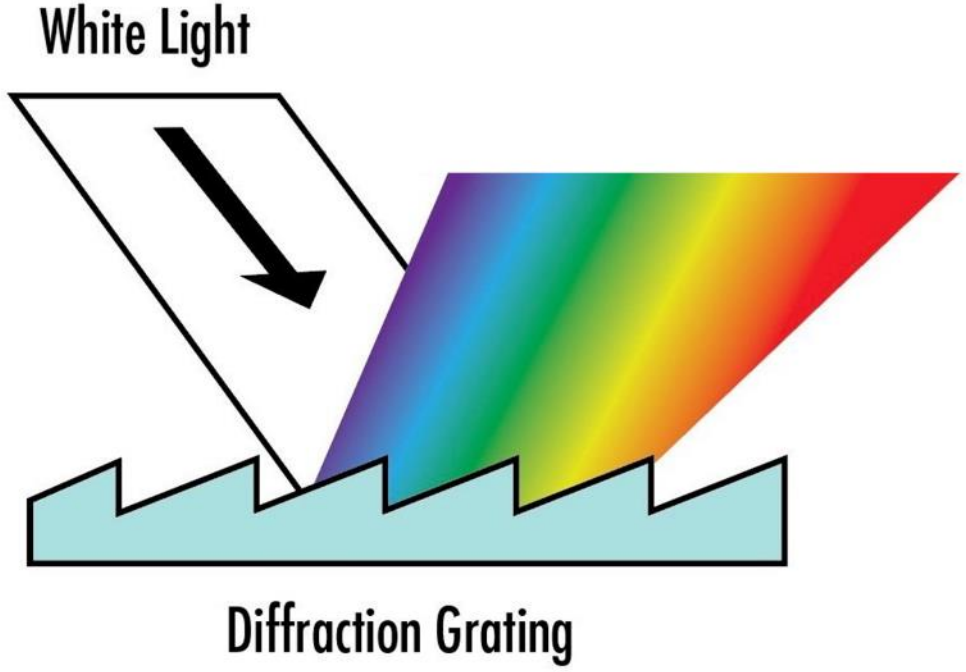
THE PHYSICS OF NANO-EMBOSSING

- Nano-embossing on Tipping Paper = surface relief grating:
  - Regular surface pattern of depressions (low reliefs) and elevations (high reliefs)



THE PHYSICS OF NANO-EMBOSSING

- Nano-embossing on Tipping Paper = surface relief grating:
  - Regular surface pattern of depressions (low reliefs) and elevations (high reliefs)
  - Interference via reflective diffraction



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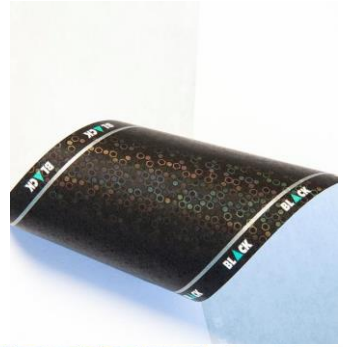
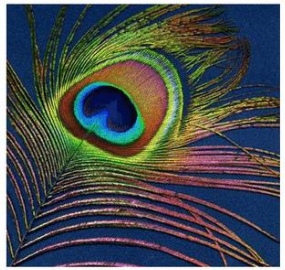
- Nano-embossing on Tipping Paper = surface relief grating:
  - Regular surface pattern of depressions (low reliefs) and elevations (high reliefs)
  - Interference via reflective diffraction
  - Examples from other areas:
    - Rainbow colors on CDs or DVDs
    - Structural colors in nature (e. g. butterflies, peacock feather, humming bird)




SUMMARY

Various levels of mechanically embossed surface structures on the Tipping Paper can be generated in order to

- activate the human haptic and visual perceptions and to
- serve as smart security feature for anti-counterfeit measures.

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THANK YOU FOR YOUR VALUABLE QUESTIONS & FEEDBACK!

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