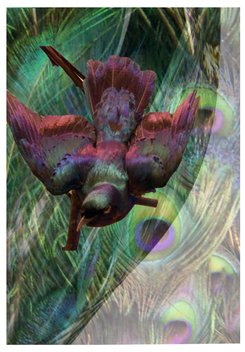


Bionic-Art
Structure.makes.Colors

S. Zobl[1],
I.C. Gebeshuber[2], W. Marx[3], T. Schwerte[4], M. Schreiner[1]
[1] Academy of fine Arts, Institute of Science and Technology in Art, Vienna, Austria

www.2art1.com
2art1@gmx.net

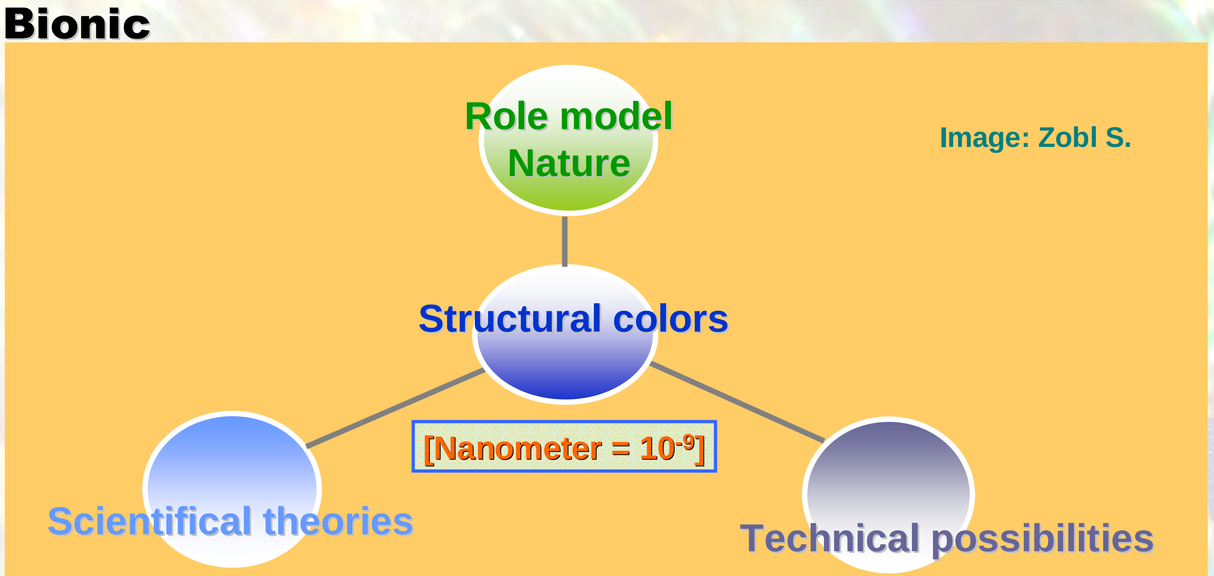
[2] Universiti Kebangsaan Malaysia, Institute For Microengineering and Nanoelectronics, Malaysia. University of Technology, Inst. of Applied Physics, Vienna, Austria. [3]Academy of Fine Arts, Institute for Fine Arts, Vienna, Austria. [4]University of Innsbruck, Institute of Zoology, Innsbruck, Austria.

ABSTRACT

Structural colors are highly attractive for artists, biologists and physicists, and have a long history in art-based research. Various investigations have been performed regarding their composition and reproduction, whereas poems and paintings tried to incorporate their marvellous properties by describing and emulating them. The blue sky, the colors of rainbows, oil films on water, soap bubbles, peacock feathers and the wings of certain tropical butterflies are the most famous examples of structural coloration in nature.

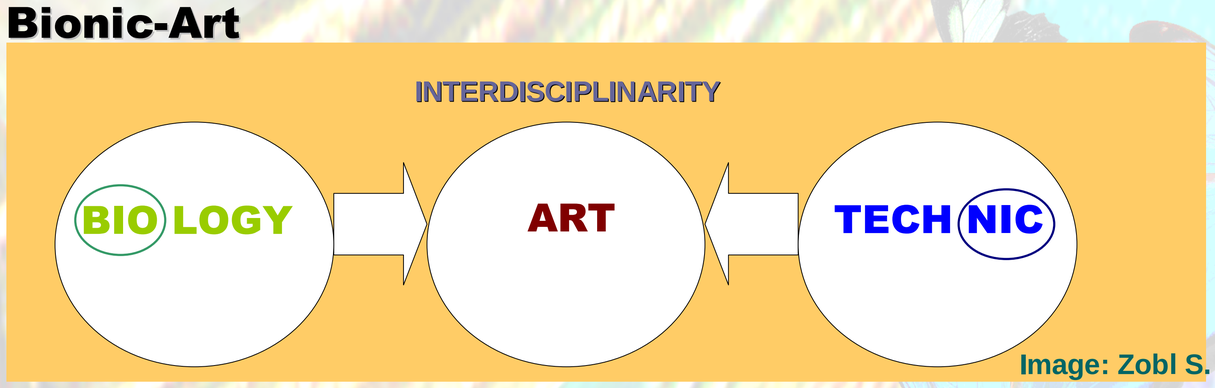
The project “Structure.makes.colors” focus on transferring these fascinating colors and their unique properties through a sophisticated material technique into the art. In one go the progressive Label *Bionic-Art* starts up with a permanent collaboration in-between artists and scientists to extend their possibilities of expression as well as broadening a better understanding of nature. The unique property of structural colors is that they are not pigmented. These colors arise through the refraction of visible light (390 – 790 nm) caused by minuscule structures due to five physical phenomena. The organic macrostructure (e.g. cover scales of a butterfly) is as much fascinating for artworks, because of their regular assemblages, and is included in the art-based science approach. The minuscule nanostructures generate iridescence through interference of light. The main aim of the project is the “brain gain” from science to art generating new techniques and the enforcement of *Bionic-Art* events for the general public and topic related persons (scientists, artists). Structural colors in nature appear similar to the visual presentation of the glamour history (Gundle, 2006). Since the 50ies shiny, strong reflecting materials with changing effects dependent on the angle of view show a spectacular presence standing for a dream world of an imaginary lifestyle in society. Glamour goes hand in hand with their physical properties, seeming not real, nor concrete, a seemingly bodiless color that only remains for a second, to suddenly disappear into another one of glimpse and glam, just like structural colors seem to be. The scientific treatment of structural colors shall produce a new generation of colors without producing additional chemical waste but durable and shiny effects that never fade. Unique structure implementations combine art with biology, attract with their beauty, and cause never-ending interest to investigate and enjoy them. The project will result in sustainable synergy between art and science, by creating *Bionic-Art*. New expression techniques will create progressive multidimensional visual impressions and a permanent communication float between art and science through workshops, lectures, books and various progressive arts. **For more information contact: info.bionic.art@gmx.net**

Bionic



LIMITLESS APPLICATION DUE TO PROGRESSIVE STATE OF THE ART DEVELOPEMENTS SCIENTIFICAL STAFF TAKE RESPONSIBILITY OF THE DIRECTION!?

Bionic-Art



Physics of Structural Colors

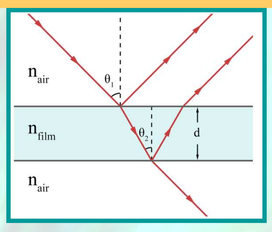
STRUCTURAL COLORS → LIGHT + Nano-STRUCTURE

3 important parameters:

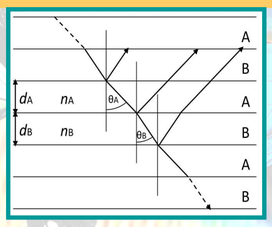
- **REFRACTION INDEX**
- **THICKNESS IN THE RANGE OF THE VISIBLE LIGHT**
- **ANGLE OF INCIDENT LIGHT AND ANGLE OF VIEW**

5 physical phenomena::

THIN FILM INTERFERENCE *e.g. Soap bubble*



MULTILAYER INTERFERENCE *e.g. Mother of pearl*



DIFFRACTION GRATING *e.g. Compact Disc*

Images [1-3]: Zobl et al., 2011.

SCATTERING *e.g. blue Sky*

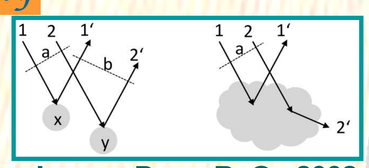


Image: Prum R. O., 2003.

PHOTONIC CRYSTALS *e.g. Opal*

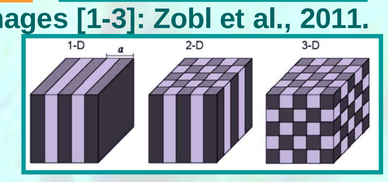


Image: Joannopoulos J. D. et al., 1995.

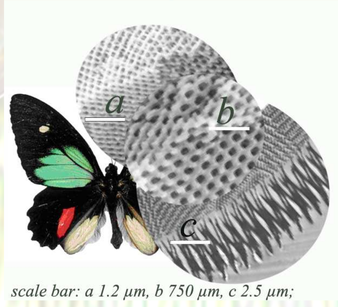
Structural colors in Nature

FAUNA	FLORA	MINERALOGY
Arthropoda	understory Plants	Opal
Aves	in Rainforests	Labradorit
Teleostei	marine Algae	Mountain Crystal
Mollusca	Leaves, Fruits, Petals	

& more

Image above shows a composition of selected structural colors in nature and of some the Nanostructure is shown with a Scanning electron microscope or Transmissionelectronmicroscope view.

***Parides sesostris* - Photonic crystals**



scale bar: a 1.2 µm, b 750 µm, c 2.5 µm;

Image above left side: *Parides sesostris*, Davis. On the right side: Detail of a Scale a) b) SEM images show photonic crystals. c) TEM image of a 50 nm section of a scale from a). Dark section is cuticle. Vukusic et al., Nature Publ. Group, 2003.

***Morpho sp.* - Shelf Structure**

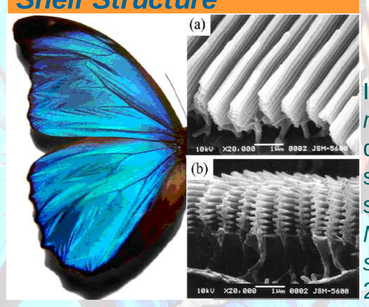


Image left side: *Morpho menelaus* Gnu free documentation License. Right side show SEM images of the structered groundscales of a) *Morpho didius* b) *M. sulkowsky*. Kinoshita et al., 2008.

Replication techniques of structural colors

- Sol gel technique
- PVD (Physical vapour deposition) e.g. CEFR (conformal evaporated film by rotation)
- ALD (Atomic Layer deposition)
- Imprint Lithographie and Casting

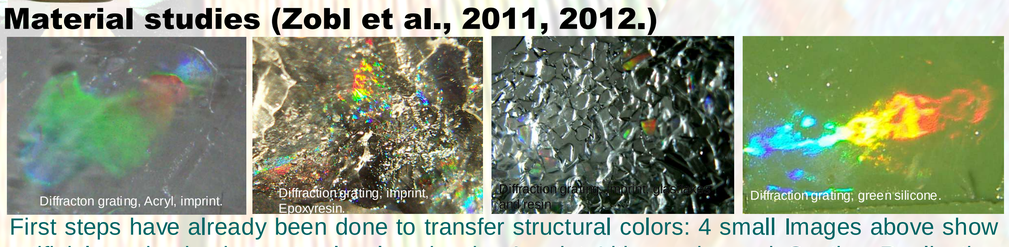
(Pulsifer et al., IOP, 2011.)

Structural coloration techniques in Art

„Effect pigments“ – effect structural colors used for coatings of e. g. cars, packaging, additives in cosmetics, security prints and for artwork. These are multilayer systems generating thin film interference with „flip-flop“ effects. They consist of flakes with alternating layers of low and high refractive index made of different basic materials like: Aluminum oxide, Borosilicate, Silicon dioxide or others coated with Oxides of Iron, Titanium, Silicon, Chromium, Copper etc. Metal oxide mica flakes are possible to equip with functional properties like corrosion limitation, magnetism, electrical conductivity, dielectric properties. Especially ones are obtainable for artwork called Pearl essence pigments or metal effect pigments. (Pfaff, 2007.)

The Artcraft is made by the enterprise LÖTZ, Witwe Lötz, Vienna (~ 1900). The iridescent colors are due to fumes of metal salts in high tempereture or wet in combination with muriatic acid. The decomposition of the glass surfaces through compounds of chlorine generates the luster (Randau, 1905). The green iridescent glass left with branch structured body, Ref.: Ricke – Ploil, Lötz, vol. 1, p.102, comp. no. 65, vol. 2, pp.88, 331, 420, 557. Image: August Lechner, für bel etage, 2004.

Material studies (Zobl et al., 2011, 2012.)



First steps have already been done to transfer structural colors: 4 small Images above show artificial synthesised structural colors by the Imprint Lithography and Casting Replication Technique. Common materials used for artworks have been investigated (Zobl et al. 2011.).

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