Lecture 1:

Structural colours in biology and how these natural micro- and nanostructures inspire current technology

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Beetles whiter than white, insects with metallic colours and butterflies with coloured wings that seem to shine by themselves, even in low light conditions – structural colours are omnipresent in biology. As opposed to pigment colours, structural colours are caused by the interaction of light with micro- and nanoscopic structural features of the biological material: total reflection, spectral interference, scattering, and, to some extent, polychromatic diffraction, all familiar in reference to inanimate objects, are also encountered among tissues of living forms, most commonly in animals.

The physical principles of the generation of structural colours will be reviewed, various examples from the animated world will be given and possible applications of biomimetic colours in man-made devices such as humidity sensors and allergy control fabrics (keyword smart colours) will be discussed.

Recommended Literature:

Kinoshita S. (2008) "Structural Colors in the Realm of Nature", Singapore: World Scientific Publishing

Matin T.R., Leong M.K., Majlis B.Y. and Gebeshuber I.C. (2010) "Correlating nanostructures with function: Structural colours in wings of a Malaysian bee", AIP Conf. Proc. 1284(1), 5-14.

Lecture 2:

The innovation potential of biomimetics for novel 3D MEMS and NEMS

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Biomimetics, i.e. knowledge transfer from biology to technology, has been around for many centuries. Yet, nowadays, the field experiences major growth – mainly because of new analysis methods that allow us to investigate and understand basic biological properties down to the nanoscale. Recurring principles of biology are correlation of form and function, modularity and incremental change, genetic basis, competition and selection, hierarchy and multi-functionality. General principles that can be applied by engineers who not at all involved in biology comprise integration instead of additive construction, optimization of the whole instead of maximization of a single component feature, multi-functionality instead of mono-functionality, energy efficiency and development via trial-and-error processes. Systematic technology transfer from biology to engineering thereby becomes generally accessible.

Exemplified by diatoms, unicellular microalgae with a cell wall consisting of a siliceous skeleton enveloped by a thin organic case, these points will be illustrated. Diatoms produce self-repairing tough underwater adhesives that serve as inspiration for novel man-made adhesives, fossil chain-forming diatoms made us come up with the idea of a new micropump, diatom hinges and interlocking devices can give hints towards optimisation of micromechanics and surface functionalisation in emerging three-dimensional micro-electro-mechanical systems (MEMS) and diatom spores and resting stages are of interest for novel building approaches in architecture.

Recommended Literature:

Gebeshuber I.C. (2007) "Biotribology inspires new technologies", Nano Today 2(5), 30-37.

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Gebeshuber I.C. and Majlis B.Y. (2010) "New ways of scientific publishing and accessing human knowledge inspired by transdisciplinary approaches", Tribology - Surfaces, Materials and Interfaces 4(3), 143-151.

Gebeshuber I.C., Gruber P. and Drack M. (2009) "A gaze into the crystal ball - biomimetics in the year 2059", Proc. IMechE Part C: J. Mech. Eng. Sci. 223(C12), 50st Anniversary Issue, 2899-2918.

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