University of Fribourg / Faculty of Science and Medicine / Adolphe Merkle Institute

Order and disorder in nature inspired 1-D photonic structures

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Colours play an essential role in the world that surrounds us. All the colours that humans and animals see are a result of the interaction of the incident light and matter, whether the origin of the colour is chemical (pigments), physical (structural colour) or combination of both. Structural colours in nature are quite common across the animal and plants kingdom and their variety and optical effects have fascinated scientists for centuries.

While the optical properties of perfectly ordered photonic crystals are well known, a similar knowledge of non-ideal structures is still missing. Such structures are often found in nature, such as in the wing scales of *Morpho* butterflies that produce vivid and shiny colours from locally disordered multilayer reflectors. Understanding the relation between order and disorder will be useful for technological applications (e.g. Bragg reflectors).

The focus of this thesis lies in the investigation of structural properties of ordered and disordered multi-layered photonic structures and their bottom-up manufacturing processes from inorganic and organic materials. Bragg reflectors can be used as a stand-alone optical sensor for detection of various gasses and liquids. Their sensing mechanism is based on changes in the physical properties of the material, change of refractive index and/or change of the materials thickness in the multi-layered stacks.

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