Lectures-01, 02 –Introduction

1.1. **What is the difference between structural color and pigment based color?**

Ans: Structural color arises due to topographical patterns on the surface with dimension in the range of wavelength of visible light so that constructive and destructive interference takes place. Pigment based color depends on absorption phenomena of light.

1.2. **What is the origin of beautiful design of butterfly wings?**

Ans: The colors on butterfly wings are because of the nano or sub micron scale physical structures present on the surface of the wings. These surfaces result in interference patterns when light is reflected by from them and hence we see different colors. In many cases, the color in butterfly as well as in many other insects is due to a combined influence of structural and pigment based coloration.

1.3. **How does Chameleons change color?**

Ans: Chameleons are a distinct class of lizards, that have limited ability to change color. Some chameleon species are able to change their skin colors. Different chameleon species are able to change different colors which can include pink, blue, red, orange, green, black, brown, light blue, yellow, turquoise and purple. Color change in chameleons helps it to camouflage. The relative importance of the classes of function varies with the circumstances as well as the species. Some adjust their colors for camouflage in accordance with the vision of the specific predator species (bird or snake) that they are being threatened by.

Chameleons have specialized cells which are know as chromatophores. These cells contain pigments in their cytoplasm, in three layers below their transparent outer skin:

1. The cells in the upper layer, called xanthophores and erythrophores, contain yellow and red pigments respectively.
2. Below these is a second layer of cells called iridophores or guanophores; these contain guanine, appearing blue or white.
3. The deepest layer of cells are melanophores, contain the dark pigment melanin, controlling how much light is reflected.

Dispersion of the pigment granules in the chromatophores sets the intensity of each color. When the pigment is equally distributed in a chromatophore, the whole cell is intensively colored. When the pigment is located only in the centre of the cell, the cell appears mainly transparent. Chromatophores can rapidly relocate their particles of pigment, thereby influencing the animal's color. Chromatophores change because the cells get a signal from brain.

It is worth pointing out that the desert dwelling Namaqua Chameleon also uses color change as an aid to thermoregulation, becoming black in the cooler morning to absorb heat more efficiently, then a lighter grey color to reflect light during the heat of the day. At times it may show both colors at the same time, neatly separated left from right by the spine.

1.4. **What is a Superhydrophobic Surface?**

Ans: A surface that exhibits a equilibrium contact angle of more than 150° and a contact angle hysteresis (CAH) of less than 10° is regarded as a super hydrophobic surface.

1.5. **What is the origin of Contact Angle Hysteresis (CAH)?**

Ans: The Contact angle measured on the advancing end of a liquid drop on a surface exceeds that of one receding from the surface. Contact Angle Hysteresis is defined as the difference between advancing and receding contact angles. This hysteresis occurs due to the various metastable states observed as the liquid meniscus travels on the surface of a solid at the solid/liquid/vapor interface. This can attributed to surface roughness, heterogeneity, solution impurities adsorbing on the surface, or swelling.

1.6. **What is the origin of lotus leaf effect?**

Ans: The lotus leaf show complete superhydrophibicity. It is the most common natural superhydrophobic surface and hence the effect is termed as lotus effect. The origin of this effect is mainly the micro scale small primary and secondary structures or pillars on the surface of the leaf. Since the drops do not come in direct contact with the surface, but effectively "float" on the surface asperities, the configuration (Cassie state of wetting) is often referred to as the "Fakir Droplets", drawing an analogy with Indian Fakirs, who could lie down on a bed of sharp nails.

1.7. **What is moth eye effect?**

Ans: Moth eye effect results in an antireflective or anti-reflection (AR) coating effect which reduces reflection. This improves the efficiency of any system since less light is lost. The inspiration is from nature by trying to mimic the natural nanostructures. Artifical anti reflective surfaces can be fabricated by creating a non close packed array of colloidal particles.

1.8. **How to classify a film to be thin?**

Ans: A film is a layer of material that is bounded between two interfaces. Though almost all objects are bounded between two interfaces, we typically call something a film, when it is thin! However, this definition is again qualitative, as one may tend to argue as what exactly is thin.

Thus, in our context we would regard a film to be thin if there is active inter-surface van der Waal forces between the two interfaces. Typically, these forces are active when the film thickness is less than ≈ 100 nm.

1.9. **What is meta-material?**

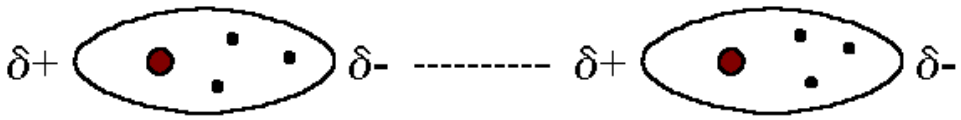
Ans: Metamaterials are engineered materials having an unique property which is know as negative refractive index that may not be found in nature. Metamaterials usually gain their properties from structure rather than composition. These materials can be used to create super-lenses which can have a spatial resolution below that of the wavelength or 'invisibility' with gradient-index materials. Metamaterials are also known as left handed materials.

1.10. **Distinguish between a stable and an unstable equilibrium.**

Ans: Equilibrium is a state of a system which does not change or vary. If the dynamics of a system is described by a differential equation, then equilibrium can be estimated by setting a derivative to zero. Equilibrium is considered if the system always returns to it after small disturbances. If the system moves away from the equilibrium after small disturbances, then the equilibrium is unstable.

1.11. **What is Dispersion Force?**

Ans: The dispersion forces are a temporary attractive force that results when the electrons in two adjacent atoms occupy positions that make the atoms form temporary dipoles. These forces are sometimes called an induced dipole-induced dipole attraction. Because of the constant motion of the electrons, an atom or molecule can develop a temporary (instantaneous) dipole when its electrons are distributed unsymmetrically about the nucleus.



1.12. **What is retarded Van der Waals force?**

Ans: The van der Waals forces are effective from a distance of a few Ångstroms to several hundreds of Ångstroms. When two atoms are a large distance apart, the time for the electric field to return can be critical, i.e., comparable to the fluctuating period of the dipole itself. The dispersion can be considered to be retarded for distances more than 100 Å, i.e., the dispersion energy begins to decay faster than 1/r 6 (~1/r 7). It is important to note that for macroscopic bodies retardation effects are more important than for atom-atom interactions.