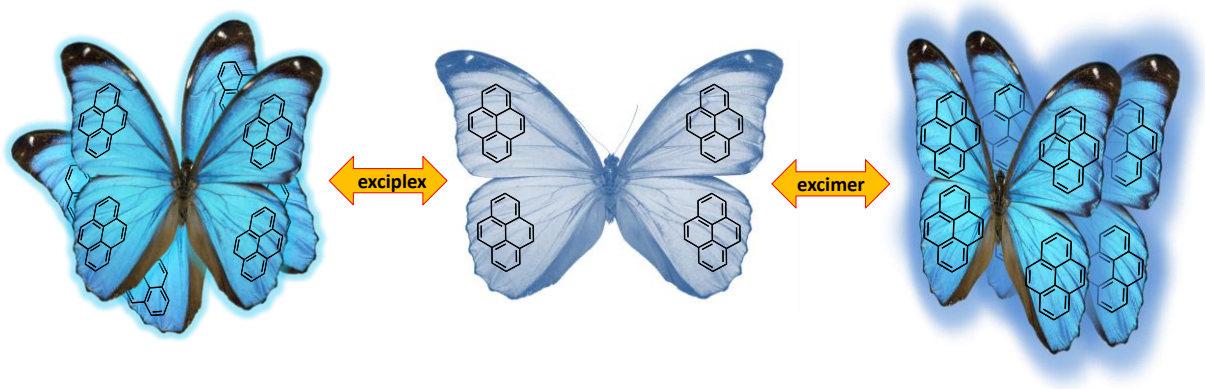
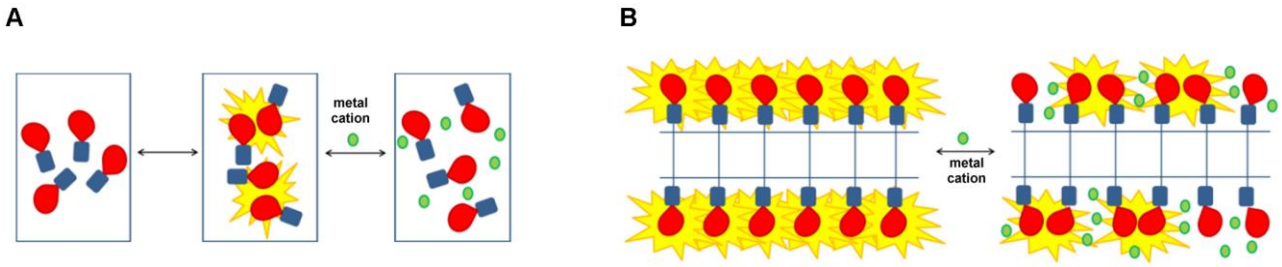
Fluorochromes situated in close proximity can interact with each other, leading to the formation of excimers (when the overlapping of the fluorochrome molecules is complete) or exciplexes (when the overlapping is only partial) (Scheme 1).



Scheme 1. Formation of excimers and exciplexes by pyrene molecules.

Formation of such systems involves changes in the optical properties of the material which can be studied with fluorescence spectroscopy and absorption spectroscopy UV-VIS. The number of chromophoric and fluorophoric moieties is large but one of the best known and most frequently reported in the literature due to its optical properties and chemical resistance is tetracyclic aromatic hydrocarbon - pyrene. Despite the voluminous scientific literature devoted to the synthesis and properties of systems containing derivatives of pyrene, most of them refers to small molecules coupled with this chromophore, which, despite the undeniable advantage of good solubility (compared to organic polymers labeled with pyrene) leads to a drastic decrease in fluorescence intensity with decreasing concentration of the solution. On increasing dilution in such systems the ability to form excimers/ exciplexes decreases significantly due to large dispersion of the particles in a solvent.

In this project new polymeric materials - poly(silsesquioxanes) of linear, ladder structure, will be prepared and used to investigate the effect of the structure of the polymer backbone and side chains [rigidity, length and the presence of heteroatoms (O, S, N)] on the optical properties of such systems. Unique structure of ladder-like poly(silsesquioxanes) bearing pyrene derivatives as substituents leads to improvement of their fluorescent properties, in comparison to small moieties, due to simplicity in the formation of excimers/exciplexes even in highly diluted solutions (Scheme 2). Application of linear, ladder-like poly(silsesquioxanes) as pyrene derivatives carriers would provide the materials with good solubility in organic systems.



Scheme 2. Formation of excimers/exciplexes and quenching the fluorescence by addition of metal cations A) in solutions of small molecules containing pyrene, (B) in regular, ladder-like silsesquioxanes bearing pyrene molecules in their side chains.

Additionally, the influence of external substances that can intercalate pyrene excimers (e.g. metal ions) on the optical properties of materials will be examined.

The preliminary results have shown that the rigidity of the main chain and the morphology of the spacer between the polymer backbone influence the optical properties of such materials. It was also shown that some metal cations (Fe^{3+}, Cu^{2+}) can interact with the system of excimers and quench the fluorescence. It suggests that the designed hybrid materials could be potentially used as sensitive and selective sensors of metal ions. Application of polymeric materials of ladder-like structure instead of small molecules should increase sensitivity, accuracy of determination of toxic pollutants, which would significantly contribute to protection of the environment and human health.