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Magnesium Porphine Supermolecules and Two-Dimensional Nanoaggregates Formed Using the Langmuir–Schaefer Technique

Larissa A. Maiorova[*†], Nagao Kobayashi[‡], Sergey V. Zyablov[†], Victor A. Bykov[§], Sergei I. Nesterov[∥], Aleksei V. Kozlov[†∥], Charles H. Devillers[⊥], Alexandr V. Zavyalov[†], Viktor V. Alexandriysky[†], Mario Orena[#], and Oskar I. Koifman[†∇]

[†] Research Institute of Macroheterocyclic Compounds, Ivanovo State University of Chemistry and Technology, 153000Ivanovo, Russia

[‡] Faculty of Textile Science and Technology, Shinshu University, Tokida, Ueda 386-8567, Japan

[§] NT-MDT, Moscow, 124482 Zelenograd, Russia

[∥] F. V. Lukin State Research Institute of Physical Problems, Moscow, 124460 Zelenograd, Russia

[⊥] ICMUB UMR 6302, CNRS, Univ. Bourgogne Franche-Comté, F-21000 Dijon, France

[#] Department Di.S.V.A., Polytechnic University of Marche, 60131 Ancona, Italy

[∇] G. A. Krestov Institute of Solution Chemistry, Russian Academy of Sciences, 153045 Ivanovo, Russia

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*E-mail: maiorova.larissa@gmail.com. Phone: +7 915 843 57 75.

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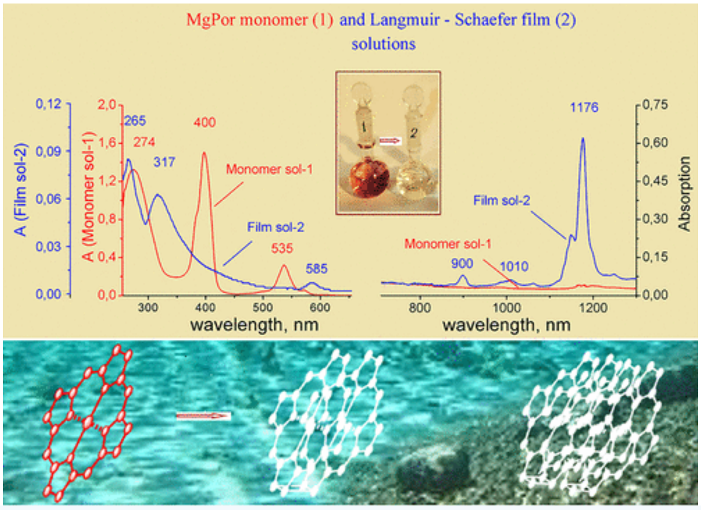
Abstract



Porphyrins are functional elements of important biomolecules, whose assemblies play a central role in fundamental processes such as electron transfer, oxygen transport, enzymatic catalysis, and light harvesting. Here we report an approach to formation of porphyrin supermolecules, a particular type of nanoparticles with unusually strong noncovalent intermolecular interactions. Key differences between the supermolecules and noncovalent nanostructures described earlier are as follows. (1) Supermolecules consist of molecules of the same type without side groups promoting the self-assembly and without any spacers; no surfactant or catalyst to assist the process is needed. (2) They exhibit unusual photophysical properties and remain stable even in organic solvents. Their formation occurs under specially selected conditions at the air–water interface at room temperature. Following this route, we have formed supermolecules of magnesium porphine, a functional element of chlorophyll. The properties of these supermolecules are markedly different from those of the constituent molecules. For example, in contrast to the pink color of the monomer solution, solutions of supermolecules are transparent for visible light and absorb in the ultraviolet and near-infrared regions. We also present atomic force microscopy visualization of the porphyrin two-dimensional nanoaggregates forming at the air–water interface that were predicted in our previous works. This approach offers a guideline for the discovery of new supermolecules, including complex biological ones, and the formation of supermolecular materials with novel properties.

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