Learning from Nature: Ecoadaptive Chemistry and Technology

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Nature rarely manipulates with single-component or pure solution chemistry: as a rule, it works with multicomponent complex systems. The nature's approach to sustain life on Earth – called metabolism, - enables smooth run of the whole chemical factories, like living organisms, and of whole ecosystems. The ecosystem metabolism includes photosynthesis fueling living systems, and humification - fueling the humic systems of non-living organic matter. While a lot of chemical disciplines are devoted to studies on living systems and biomimetic technologies, much lesser attention is given by modern chemistry to the systems of non-living organic matter, which play crucial role in adaptation of living organisms to the changing environment. The functions of humic systems include regulation of transport and availability of biogenic elements to plants, immobilization and mitigation of toxicity of hazardous elements in the contaminated ecosystems, protection of plants from non-specific abiotic stresses, maintenance of soil fertility, mediation of microbial redox reactions, etc. The long-term exploration of molecular machinery, which underlay these complex biotic-abiotic interactions, have convinced us in necessity of introducing and developing new field of chemistry, nominally, Ecoadaptive Chemistry and Technology [1]. Its major goal is in understanding molecular mechanisms of self-organization, which underlay sustainability and adaptation of biogeochemical systems to the ever changing environmental conditions, and to reproduce them in materials, processes, and technologies. This paper will represent a novel platform for nature-inspired synthesis of soft and hybrid (nano)materials aimed at their use for soil and water clean up, landfills sanitation, carbon sequestration, soil fertility restoration. It is based on a smart use of humic substances, which possess multiple functional groups. This makes HS amenable both for classical chemical modification as well as for producing interpolyelectrolyte complexes. Prospects of nature-like design of nanofertilizers, soil meliorants, biocatalytic systems will be demonstrated.

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