

Design of Task-Specific Novel Nanomaterials from Ionic Liquids and GUMBOS: Studies on Their Sensing, Fluorescence Resonance Energy Transfer, and Biomedical Applications

Abstract:

The dissertation presents the strategic synthesis of some task-specific novel nanomaterials from ionic liquids (ILs) and group of uniform materials based on organic salts (GUMBOS) and the judicious utilization of such systems in sensing, fluorescence resonance energy transfer, and biomedical purposes. The ILs and GUMBOS are the novel class of organic salts that can be easily converted to nanomaterials (nanoGUMBOS) and hence, become one of the most promising materials nowadays in various applications including extraction and separation, sensing, electrochemistry, biocatalysis, active pharmaceutical ingredients (APIs)-loaded drug carrier, energy field, and so on.

Any device that can mimic human gustatory and olfactory processes is considered as an object of immense interest. The first part of this dissertation highlights the fabrication of a pH-sensitive dye (methyl orange)-based IL as well as GUMBOS and nanoGUMBOS sensors which exhibit improved spectral sensitivity for acids and bases in both the polar and non-polar solvents. The as-prepared IL-based indicator was further exploited to determine the dissociation constants of some acids in a less polar solvent which invokes the synthesis of a series of task-specific sensors based on ILs and GUMBOS. The second part of the dissertation portrays the preparation of a novel pyrene butyric acid-based aqueous-suspended nanoGUMBOS. Inside these nanoGUMBOS, the nature of association of the organic moieties in their ground state as well as electronic excited state has been explored in detail. The nanoGUMBOS is highly suitable for transferring photonic energy to hydrophobic dyes selectively which makes the system a potential smart tool in energy relay applications. This nanoGUMBOS is also very effective in the quantitative delivery of APIs in a controllable way and hence, can be utilized as a novel drug delivery system. Furthermore, considerable focus has been cast on the development of ILs and GUMBOS having useful biological activities in recent days. In the last part of the thesis, a novel vitamin E-based nanoGUMBOS has been fabricated. This nanoGUMBOS owns higher solubility, stability, antioxidant activity, and also better cellular bioavailability as compared to the free form of vitamin E in physiological medium, and hence, paves a new avenue in current pharmaceutical research. Overall, the dissertation demonstrates a number of notable advantages of ILs and GUMBOS-based nanomaterials over their parent molecular systems.

Keywords: Ionic liquids, GUMBOS, nanoGUMBOS, task-specific, pH-sensitive, dissociation constant, electronic excited state, energy relay, active pharmaceutical ingredients, drug delivery system, antioxidant activity, bioavailability.