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Exploring Photoreactive Coordination Compounds: The Role of Re Complexes in Ibuprofen Photosensitized Decomposition

Authors : Emilia R. Serrano, Pedro M. David Gara, Gustavo T. Ruiz

Abstract : Water pollution is an urgent global issue, impacting not only the availability and quality of water for consumption but also the health and lifestyle of populations worldwide. One growing concern is the presence of pharmaceuticals in natural waters, which pose significant risks to both the environment and public health. These substances, even in trace amounts, can cause physiological effects that are often undetected due to insufficient monitoring. Among the many compounds of concern are caffeine, paracetamol, ibuprofen, and enrofloxacin, all of which have been detected in rivers across Argentina. These substances are part of a broader class of emerging pollutants (EPs), which also include chemicals from household and personal care products. The environmental dangers posed by EPs are substantial, particularly their effects on the biotic components of aquatic ecosystems. Bioaccumulation of these pollutants has been observed in various aquatic organisms, raising concerns about long-term ecological impacts. Additionally, continuous exposure to EPs has been linked to a range of harmful effects, including cytotoxicity, genotoxicity, apoptosis, and functional impairments in living organisms. More alarmingly, the prevalence of antibiotics in the environment contributes to the growing issue of antibiotic resistance, creating a significant global health crisis. Unfortunately, these pollutants often go unnoticed during routine water quality assessments, which underscores the need for innovative approaches to mitigate their impact. One promising solution lies in the use of transition metal coordination compounds as photosensitizers, which can help degrade EPs through photocatalytic processes. Transition metals like rhenium (Re) form stable complexes with organic ligands, and these Re(I) complexes (ReC) exhibit tunable photophysical and photochemical properties based on metal-ligand combinations. By focusing on bi-azinic ligands, we aim to optimize the behavior of Re(I) complexes, enhancing their efficiency as photosensitizers in the degradation of harmful pollutants. ReC molecules are of particular interest due to their excellent thermal and photochemical stability, as well as their ability to facilitate electron transfer and redox reactions. When activated by light, these complexes generate reactive species capable of breaking down toxic pollutants into less harmful byproducts. This photo-driven degradation process offers a sustainable and environmentally friendly approach to removing EPs from natural waters, reducing their impact on aquatic life and human health. The unique properties of ReC, such as their excited-state behavior and efficient energy transfer, make them highly suitable for photocatalytic applications aimed at mitigating water pollution. The methodology employed in this research integrates several techniques to explore the effectiveness of ReC in pollutant degradation. These include optoacoustic measurements, absorption and fluorescence spectroscopy, laser flash photolysis, and the use of a phoreactor to simulate real-world conditions. Our recent results showed that a ferrocene-rhenium complex with phenanthroline enhanced the photodegradation of ibuprofen under oxidizing conditions. While promising, further studies, such as HPLC, are needed to determine the exact nature of the degradation products and assess the efficiency of the process. Through this approach, this research aims to contribute to the development of efficient, green technologies for degrading emerging pollutants in natural waters.

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