

3,4-Dihydro-1,3,2H-Benzoxazine: Various Applications of Basic Monomers

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Abstract

Benzoxazine monomers (3,4-dihydro-1,3,2H-benzoxazines) are heterocyclic compounds consisting of fused benzene and oxazine rings, typically synthesized via the Mannich reaction from primary amines, paraformaldehyde, and phenols¹. A wide variety of benzoxazine monomers has been developed, serving as key precursors for polybenzoxazines with tunable properties for advanced applications².

Beyond their conventional role, benzoxazine monomers have recently emerged as multifunctional materials. They can act as ligands for rare-earth ions such as Ce(III), forming complexes that serve as precursors for CeO₂, in catalytic reforming systems³⁻⁶. Remarkably, despite lacking classical reducing groups, they exhibit intrinsic reducing ability toward precious metal ions such as Ag(I)^{7,8}, enabling the formation of metal-coated substrates including TiO₂, SiO₂, carbon black, chitosan, and poly(vinyl alcohol)⁹⁻¹². These materials, particularly Ag-TiO₂, have been incorporated into poly(lactic acid) (PLA) to produce golden, antibacterial fibers and fabrics¹³.

Benzoxazine monomers also display intrinsic luminescence under UV irradiation, as first observed by our group¹⁴. Building on this, poly(acrylic acid)-grafted benzoxazines (PAA-g-BZX) were synthesized and used as luminescent additives for PLA, enabling 3D printing of golden filaments with green emission without inorganic phosphors¹⁵. Furthermore, benzoxazines can initiate ϵ -caprolactone polymerization to form functional additives that enhance fluorescence and mechanical properties¹⁶. Their complexation ability also improves processability in stereolithography (SLA) and enhances dielectric performance^{17,18}.

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Personal History:

Dr. Apirat Laobuthee is a Thai academic and researcher specializing in polymer science and advanced functional materials. He received his B.S. in Chemistry from King Mongkut's Institute of Technology Thonburi in 1993 and subsequently obtained his M.S. (1997) and Ph.D. (2002) in Polymer Science from The Petroleum and Petrochemical College, Chulalongkorn University.

He is currently an Associate Professor in the Department of Materials Engineering, Faculty of Engineering at Kasetsart University, where he has served in several leadership roles, including Deputy Head of Department. His academic career spans more than two decades, with extensive experience in teaching, research, and academic administration.

Dr. Laobuthee's research focuses on advanced functional materials, particularly benzoxazine-based systems, biodegradable polymer composites, nano-silver materials, and ceramics for energy and environmental applications. He has made significant contributions to international publications and has received numerous prestigious awards, including the National Outstanding Teacher Award in Science and Technology (2024), as well as multiple recognitions for academic excellence, research, and textbook authorship.

Research Keyword:

Benzoxazine monomers, Host compound, Benzoxazine-metal complexes, Reducing agent, Luminescent materials