

The Multidisciplinary Weapon: Harnessing Six Branches of Chemistry to Combat Antimicrobial Resistance

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Abstract

Antimicrobial resistance is one of the defining health threats of our time, rendering once-reliable antibiotics increasingly powerless against common infections. Tackling this problem effectively requires more than a single line of attack, it demands chemistry working across its own internal boundaries. This presentation showcases how organic synthesis, inorganic and coordination chemistry, physical chemistry, biochemistry, analytical chemistry, and computational chemistry can be combined into a single coherent strategy for fighting resistant bacteria.

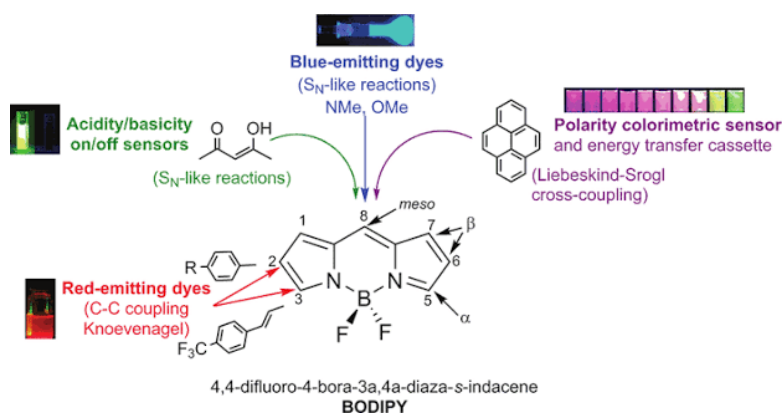


Fig.1 – BODIPY dye structure and tunability

At the center of this approach are BODIPY dyes, small, tunable fluorescent molecules built around a boron-containing core (Fig.1). They are engineered to act as light-activated antimicrobial agents.[1,2] Organic synthesis provides the molecular scaffolds; inorganic chemistry shapes their boron-based architecture and enables anchoring onto hybrid clay materials; physical chemistry explains and optimizes how these molecules absorb light and generate reactive species that damage bacterial cells; biochemistry governs how the dyes are integrated into the bacteria; analytical techniques confirm structure and purity at every step; and computational chemistry predicts and rationalizes molecular behavior before it is ever tested on the bench.

By treating chemistry not as a collection of separate subfields but as an integrated toolkit, this work illustrates how interdisciplinary thinking can accelerate the search for new, light-based weapons against antimicrobial resistance.

(1) "BODIPY Dyes and Their Derivatives: Syntheses and Spectroscopic Properties", A. Loudet and K. Burgess, Chemical Reviews, Vol. 107 (2007) 4891-4932.

(2) "The chemistry of fluorescent bodipy dyes: versatility unsurpassed", Ulrich G, Ziessel R, Harriman A. Angewandte Chemie International Edition, Vol. 47 (2008) 1184-1201.