

Review

Recent Advances in Luminophores for Enhanced Electrochemiluminescence Analysis

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Abstract: Electrochemiluminescence (ECL) detection is widely applied in many fields, including chemical measurement, biological analysis, and clinic tests, due to its high sensitivity. Currently, the fast development of many new electrochemical luminophores is continuously improving the ECL-based detection ability. Besides the enhancement of luminescence emission for a high detection sensitivity, minimizing the effect of co-reactants on ECL detection and achieving multiple analysis in one sample are also the main directions in this field. This review focuses on a summary of recently prepared new luminophores to achieve the three aims mentioned above. Especially, the review is composed by three parts, focusing on the luminophores or materials with high ECL efficiency, self-enhancing properties, and multi-color ECL luminophores. The fabrication of biosensors using these molecules is also reviewed to exhibit the advances in biological applications.

Keywords: electrochemiluminescence detection; high-luminescent luminophores; intramolecular luminescent luminophores; spectral-dependent luminophores; biosensing



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1. Introduction

Electrochemiluminescence (ECL) is a light emission process that includes the redox reactions on the electrode surface under a certain voltage. Since the luminescent reagent is excited and emits light without the need for any other light source, ECL has the advantages of a high sensitivity and low background signal [1–3]. Accordingly, since its discovery, electrochemiluminescence (ECL) technology has received great attention from the scientific community and has been widely applied in the fields of biological analysis, environmental monitoring, food safety, and medical diagnosis [4–9]. Typically, the annihilation and co-reaction pathways are two popular mechanisms for ECL, in which the co-reactive pathway is mostly used [10–13]. In this pathway, the luminescent reagent (e.g., ruthenium complex) is oxidized or reduced at the electrode, and the co-reactants (e.g., tri-*n*-propylamine or hydrogen peroxide) help the luminescent reagent to generate excited-state substances and provide additional electrons or reaction intermediates [14,15]. The intermediate is energetically unstable, and thus, it returns to the ground state, releasing energy and emitting visible light in the form of photons. The involvement of co-reactants not only improves the luminescence efficiency but also increases the sensitivity. It is noted that the presence of co-reactants can still lead to some negative effects, such as increased background noise and instability of the ECL signal.

Luminophores and co-reactants, electrode materials, pH, potentials, etc., have a great impact on ECL generation and the performance of ECL analysis [16–19], among which luminophores are the most important component in ECL detection. These luminophores with different luminescence efficiencies determine the sensitivity and effective detection range of ECL analysis. Therefore, obtaining new luminophores with high ECL efficiency is always the first task in this field. Thanks to the rapid development of materials science, ECL detection technology is experiencing an unprecedented development momentum,

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