

Nanotechnology-based Strategies for Enhanced Electrochemiluminescence Biosensing

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The increasing significance of nanotechnology and nanosystems in chemical and materials science over the past decade had a profound impact on the development of new technologies. The integration of these nanosystems with electrochemiluminescence (ECL) has given rise to novel methodologies for analyte determination, even within highly complex matrices.

ECL is luminescence generated by electrochemical reactions, and it offers superior spatio-temporal control and minimal background interference compared to photoluminescence or other optical methods that rely on external light illumination. Over the last two decades, ECL has proved to be a versatile and powerful analytical technique, finding applications in different fields, ranging from fundamental research to commercial clinical and biological applications. Given its surface-confined nature, precise control over the spatial distribution of ECL signals at nanoscale distances is crucial for its application in sensing devices.

Herein I will present some recent strategies in which nanomaterials are used as tool for exploring the mechanism underlying ECL signal generation at nanoscale according to the “oxidative-reduction” scheme using tri-n-propylamine (TPrA) as a coreactant and Ru(bpy)₃²⁺ as a luminophore. By unraveling the intricate processes governing ECL at the nanoscale, these strategies enable to develop highly sensitive and specific biosensors.

Additionally, I will provide an overview of nanofabrication techniques that I have worked with, elucidating how they can be employed to create nanostructured surfaces for biosensing and lab-on-chip applications.