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Afterglow Electrochemiluminescence with Tris(2,2'-bipyridyl)ruthenium(II) chloride and Potassium Persulfate

Afterglow electrochemiluminescence with $Ru(bpy)_3^{2+}$/persulfate extends light lifetime to over a minute, enabling brighter assays, imaging, and displays.

Researchers at Purdue University have developed an electrochemical system using Ruthenium II tris(bipyridine) ([Ru(bpy)3]2+), the most used and brightest luminophore, that is capable of releasing light for over a minute rather than in the microsecond range as is currently available. Electrochemiluminescence (ECL) is typically characterized by the release of photons upon the application of a potential difference. In current ECL systems, the maximum luminescent lifetime of the [Ru(bpy)3]2+ ion was in the microsecond range, limiting the use of these types of systems for chemical/biological assays and displays. Additionally, expanding the light production into three dimensions (rather than just on the surface of the electrode) is another sought-after characteristic due to the potential for much higher light-emission density per unit volume.

The researchers developed an ECL system with [Ru(bpy)3]2+ and other coreactants that, upon application of a voltage, will induce the formation of crystals starting from the electrode surface. The crystals will continue to grow, releasing photons in the process. Once the voltage is cut, light is released as the crystals dissolve back into the solution, producing a glow lasting over a minute, depending on the experimental conditions.

Technology Validation:

The researchers verified the growth of the crystals from the electrode surface via a microscope, seeing the crystal growth in real time, reaching a maximum of ~170 micrometers from the surface. It was observed that the tips of the crystals had an increased ECL signal as compared to the bulk. The vast increase in luminescent lifetime was observed by applying a potential for 100 seconds, ceasing the potential, and measuring the intensity of light released from the solution over time. The researchers observed a total

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Authors
Jeffrey Dick
Brady Layman

Further information
Aaron Taggart
adtaggart@prf.org

View online

luminescent lifetime of 63 seconds, after which the intensity rapidly decreases.

Related Publications: Electroprecipitating the Sulfate Radical Anion Amplifies Electrochemiluminescence in Space and Time. Brady R. Layman and Jeffrey E. Dick. Journal of the American Chemical Society 2024 146 (38), 26216-26222. DOI: 10.1021/jacs.4c07852

Advantages:

- Vastly improved luminescent lifetime (from microseconds to over a minute)

- Low complexity system

- Commonly used reagents

Applications:

- Biomedical imaging

- Electrochemical assays

- Biological assays

- Displays

TRL: 3

Intellectual Property:

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