Advances in optical and electrochemical techniques for biomedical imaging

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As the flagship journal of the Royal Society of Chemistry, this retrospective themed collection in \textit{Chemical Science} collects some exceptionally significant and highly representative publications from the imaging field. The types of articles include both edge articles and minireviews, mainly covering optical imaging (for minireviews please see ref. 1–3) and electrochemical imaging (for a minireview please see ref. 4).

Optical methods serve as widely practicable techniques for biological imaging. Fluorescence in the NIR region (>700 nm) is superior in biomedical sensing due to the high penetration depths and low autofluorescence interference. To make this technique more applicable for \textit{in vivo} detection, novel biocompatible fluorescent probes with high selectivity and sensitivity are urgently needed in this field. This motivation drives various new strategies in molecular design.

For example, a small molecule NIR fluorescent probe, ACy7, was designed for \textit{in situ} visualization of ozone in the brains of mice, which incorporates a Cy7-like molecule as the precursor of the fluorophore and 3-butenyl as the recognition group.\textsuperscript{3} The plasma membrane could be specifically imaged by a water-soluble near-infrared (NIR)-emissive fluorescent molecule with aggregation-induced emission (AIE).\textsuperscript{6} This fluorescent “light-up” probe allows a short staining period (at the second-level) with a wash-free process. Further, a fluorophore–peptide conjugate was developed for tumor imaging in the “transparent” near-infrared II (NIR-II) window with rapid renal excretion and low off-target tissue exposure.\textsuperscript{7} Meanwhile, a semiconducting polymer nanoparticle is designed for efficient NIR-II image-guided tumor surgery by using multiple pathological models.\textsuperscript{8} These methods promote clinical translation in disease diagnosis and surgical treatment. We are pleased to see that machine learning has been involved in predicting material properties,\textsuperscript{9} and could be expected to facilitate the design of novel fluorescence probes.

In addition, new highly sensitive optical methods have been developed for sensing and imaging. For example, a unique hand-held surface enhanced near-infrared (NIR) microcopy techniques. Specifically, the electrochemical impedance spectroscopy of individual nanoparticles was imaged on a dark-field microscope with an optical-to-electrochemical conversion.\textsuperscript{14} Accordingly, the electrocatalytic activity of 2D materials could be imaged directly by electrochemiluminescence microscopy (ECL), presenting nonuniform ECL distribution at single particles.\textsuperscript{15} ECL microscopy could facilitate the imaging and study of electrochemistry collision behavior of single ECL nano-emitters.\textsuperscript{16} Since the design of new ECL emitters has attracted growing interest, a new near-infrared aggregation-induced enhanced ECL emitter has been developed that shows high ECL efficiency and excellent...
The thriving research on nanoscale electrochemistry will likely accelerate the exploration of new chemistry through single entities. As guest editors of this themed collection, we thank all the authors for their outstanding contributions. We have brought together high-quality articles on the theme of imaging, especially optical and electrochemical imaging, in this themed collection. We hope researchers from various fields will enjoy examining this themed collection.

References