Chinese Chemical Letters 34 (2023) 107991

Contents lists available at ScienceDirect

Chinese Chemical Letters

journal homepage: www.elsevier.com/locate/cclet

Editorial

# High-resolution and instantaneous imaging of latent fingerprints

Fingerprints can serve as an information storage platform for individuals and play an important role in forensic investigation and security [1]. Most of them are invisible to the naked eye and are called latent fingerprints (LFPs). Conventional imaging techniques suffer from limitations like low resolution and sensitivity [2], restricting the recognition of LFPs to macroscopic features, such as shape, core, ending, bifurcation, island, pores, and so on, which correspond to levels 1 and 2. Features of level 3 including ridges and their edges, are challenging to recognize.

In the last decade, aggregation-induced emission (AIE) materials [3] have shown a great potential in visualizing LFPs due to their high brightness, colorful fluorescence, and easy functionalization characteristics [4,5]. In 2012, Su's group reported the first example of the use of tetraphenylethene as the probe for recognizing LFPs based on AIE [6]. This work solved the aggregation-induced quenching problem and demonstrated that AIE molecules had a great potential in the field of LFPs recognition. In 2018, Singh and co-workers used the ESIPT-coupled AIE strategy to perform the visualization of LFPs in a 90:10 $H_2O/CH_3CN$ mixture [7]. Compared to the previous work, the longer wavelength emission is beneficial for increasing the visibility or the contrast of the developed LFPs against the background surface. Recently, Xia's group reported AIE-active Ir(III) complexes achieving high-definition development of LFPs in $CH_3CN/H_2O$ solvent mixtures [8]. The LFPs photographs in this work were legible enough to allow the display of level 3 details. Despite these advances, several issues still hamper the practical application of AIE probes in this field: 1) Most AIE probes use binary organic solvent mixtures, which easily causes fingerprints damage; 2) Some probes require a longer incubation time to ensure higher contrast; 3) In-depth understanding of the plausible mechanism for the visual imaging of LFPs at the molecular level is still underdeveloped in most cases.

To address these issues, Prof. Tao Tu and co-workers from Fudan University recently reported an efficient water-soluble terpyridine complex **Zn(tpy-NMe$_2$)** for high-resolution instantaneous visual imaging of LFPs in pure water system in *Advanced Materials* (Fig. 1) [9]. Specifically, the introduction of Zn(II) gave it excellent fluorescence properties, while the acetate was employed to increase water solubility of the probe.

Remarkably, distinguishable LFPs patterns could be developed by **Zn(tpy-NMe$_2$)** within 1 s, and level 3 details could be revealed within 3 s in pure water. Based on this instantaneous imaging behavior, the rubbings of LFPs images could be readily duplicated using forensic fingerprint tapes, which showed its excellent replicability (Fig. 1a). In the magnifying images of LFPs, level 3 details were clearly observed. Fluorescence images also showed that the widths of different ridges could be clearly distinguished (*ca.* 200-300 nm), illustrating the high-resolution and contrast of the protocol (Fig. 1b). Moreover, benefiting from the easy modification of tpy ligands, the substituents could be readily modified, allowing the systematic adjustment of the fluorescence colors of the probes (Fig. 1c). These outcomes further enhanced the real-life applicability of the newly developed approach.

As supported by high-resolution mass spectrometry (HR-MS), $^1$H NMR, scanning electron microscopy (SEM), and the successful isolation of the adduct complex **Zn(tpy-NMe$_2$)-OA** (OA = oleic acid), a plausible mechanism of visualization of LFPs developed by **Zn(tpy-NMe$_2$)** was then proposed. As shown in Fig. 1d, when the LFPs sample was immersed into or sprayed with the aqueous probe solution, the OA molecules within the LFPs ridge could selectively and quickly coordinate to the Zn center of the probe by replacing $OAc^-$. The probe molecules then anchored to the LFPs ridge to form the adduct **Zn(tpy-NMe$_2$)-OA**, which self-assembled through $\pi-\pi$ stacking at the interface. This resulted in the observed AIE emission possibly due to restriction of intramolecular motions [9].

Tu's group utilized a supramolecular assembly strategy and employed Zn(II) complexes to improve fluorescent properties and enhance the ability to bind components in LFPs selectively. This work provides an efficient approach for practical LFPs recording and analysis in different scenarios. This study sheds light on the structure modification of coordination compounds-based AIE probes that may also be suitable for the identification of criminals and practical tools for controlling crime.

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https://doi.org/10.1016/j.cclet.2022.107991

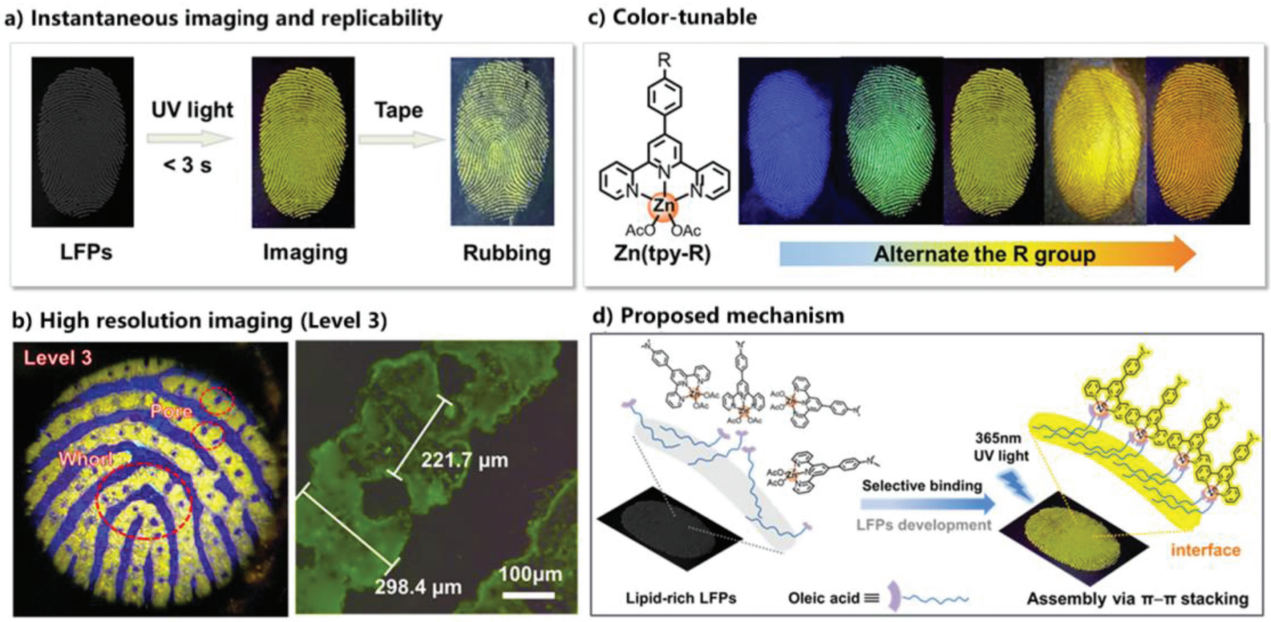


**Fig. 1.** (a) Instantaneous visual imaging process using **Zn(tpy-NMe$_2$)** as probe in pure water and its replicability. (b) High-resolution imaging developed by **Zn(tpy-NMe$_2$)**, including level 3 details. (c) The chemical structure of **Zn(tpy-R)** and color-tunable features of the developed LFPs images. d) The proposed mechanism of visual imaging process using **Zn(tpy-NMe$_2$)** as probe. Reproduced and adapted with permission [9]. Copyright 2022, Wiley-VCH.

Received 17 October 2022
Revised 30 October 2022
Accepted 3 November 2022
Available online 13 November 2022

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