Journal of Colloid and Interface Science 528 (2018) 200–207

Contents lists available at ScienceDirect

Journal of Colloid and Interface Science

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

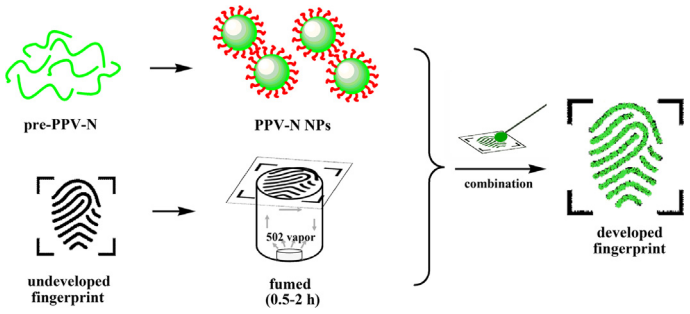
Regular Article

Fluorescence development of fingerprints by combining conjugated polymer nanoparticles with cyanoacrylate fuming

Hong Chen [a,c,1], Rong-liang Ma [b,1,*], Zhinan Fan [a], Yun Chen [a], Zizheng Wang [b], Li-Juan Fan [a,*]

[a] State and Local Joint Engineering Laboratory for Novel Functional Polymeric Materials,Department of Polymer Science and Engineering, College of Chemistry, Chemical Engineering and Materials Science, Soochow University, Suzhou, Jiangsu 215123, PR China
[b] Institute of Forensic Science, Ministry of Public Security, Beijing 100038, PR China
[c] School of Nano-Science and Nano-Engineering, Xi'an Jiaotong University Suzhou Research Institute, Suzhou 215123, PR China

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 27 March 2018
Revised 21 May 2018
Accepted 22 May 2018
Available online 23 May 2018

Keywords:
Fluorescent development
Superglue fuming
Fingerprint
Conjugated polymer nanoparticles
Tuned emission

ABSTRACT

Selecting appropriate developing methods/reagents or their combination to enhance the effect for fingerprint development is of great significance for practical forensic investigation. Ethyl-2-cyanoacrylate ester (superglue) fuming is a popular method for "in-situ" developing fingerprints in forensic science, followed by fluorescence staining to enhance the contrast of the fingerprint image in some occasion. In this study, a series of fluorescent poly(*p*-phenylene vinylene) (PPV) nanoparticles (NPs) in colloidal solution were successfully prepared and the emission color was tuned via a simple way. The fuming process was carried out using a home-made device. The staining was accomplished by immersing a piece of absorbent cotton into the solution of NPs, and then gently applied on the fumed fingerprints for several times. The PPV NPs were found to have a better developing effect than Rhodamine 6G when excited by 365 nm UV lamp. Different emission colors of NPs are advantageous in developing fingerprints on various substrates. Mechanism study suggested that the NPs were embedded in the porous structure of the superglue resin. In all, the combination of fuming method with the staining by conjugated polymer NPs has been demonstrated to be successful for fluorescent fingerprint development and be promising for more practical forensic applications.

1. Introduction

Fingerprint has played an important role in criminal investigation due to its uniqueness to each individual person. Obtaining fingerprints with clear and recordable patterns is crucial for

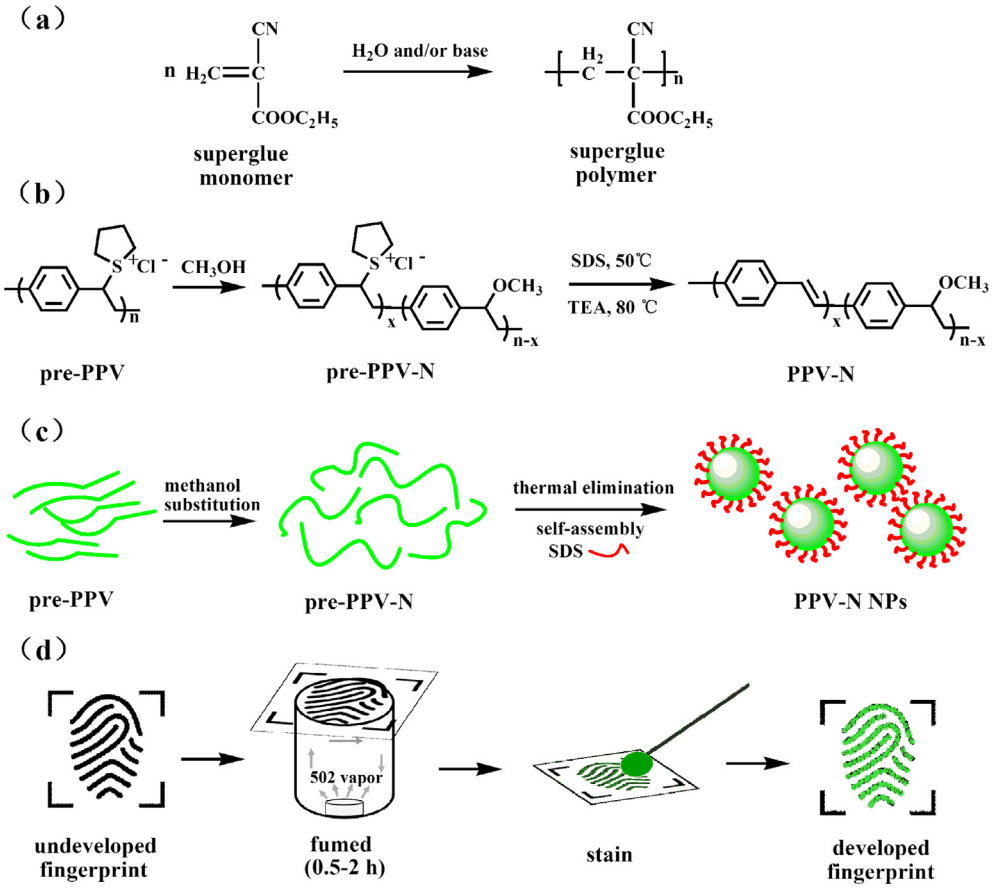
* Corresponding authors.
E-mail addresses: marl2013@163.com (R.-l. Ma), ljfan@suda.edu.cn (L.-J. Fan).
[1] These authors contributed equally.

https://doi.org/10.1016/j.jcis.2018.05.079
0021-9797/

recognizing the identities of the criminals. Conventional methods and reagents employed for fingerprint development have been reported and each method and/or reagent had advantages and limitations [1]. Choosing an appropriate combination of method and reagent for developing fingerprints on a specific fingerprint substrate in a real situation may facilitate the detection of the criminal case. For examples, dusting with powder is preferred when dealing with fingerprints on a non-porous substrate [2]; staining with ninhydrin solution followed by fuming over the hot water steam is usually used for develop fingerprints on paper [3]. Fuming with superglue is often employed for "in-situ" developing fingerprint on various substrates [4–6].

Fuming with superglue has been demonstrated to be one of the most robust methods for fingerprint development, and becomes more and more popular due to its convenience and superior effect. Superglue, also named ethyl-2-cyanoacrylate ester, is a kind of extremely strong adhesive. The superglue was first employed to develop fingerprint by the Criminal Identification Division of the Japanese National Police Agency in 1978 [1]. Since then, scientists have devoted continuous efforts to enhance the effect of development and extend the range of application for this cyanoacrylate fuming method [7–10]. The principle and the reaction for this method have been well studied [11,12]. Once the substrate is placed in a cabinet equipped with an air circulation device and a humidifier, the cabinet will be filled with gaseous ethyl-2-cyanoacrylate ester in several minutes; and the ethyl-2-cyanoacrylate ester will polymerize in the substrate surface where there is a fingerprint, resulting in a white and obvious fingerprint pattern. Appropriate heating can accelerate the evaporation and the polymerization of superglue. The chemical structure of superglue and its polymerization reaction scheme are shown in Scheme 1a.

There are several advantages for superglue fuming method. First, it can develop fingerprint in situ without affecting the properties of the substrate. Second, it can avoid the destruction on the pattern and details of fingerprint, as what may happen in other methods due to the direct contact of solvent or being exerted with external force. In addition, the developing procedure is relatively simple and universal to various substrates. However, sometimes the as-developed fingerprint by superglue lacks enough contrast for identification, especially on light-colored substrates, since the resulting cyanoacrylate ester resin is of white color. In addition, the interference from some colorful backgrounds may also reduce the resolution of fingerprint patterns. There have been many reports about using fluorescent reagent for fingerprint development, demonstrating good developing effect [13–17]. However, powder-dusting and dipping/swaying in solution were commonly adopted as the developing methods in these reports. There also are some reports employing fluorescent reagents to enhance the developing effect, such as organic dyes and quantum dots (QDs) by staining the fumed fingerprints [7,18,19]. Such fluorescent staining successfully enhanced the contrast between the fingerprint ridge and furrow; and avoid the interference from background. The most commonly used fluorescent reagent in developing fingerprint is Rhodamine 6G (R6G) or its derivative [10,20]. However, R6G emits red fluorescence, and has an



Scheme 1. (a) The chemical reaction scheme during the solidification of superglue; (b) the reaction scheme for the methanol substitution and thermal elimination process during the preparation of PPV NPs (SDS and TEA are the abbreviations for sodium dodecyl sulfonate and triethylamine, respectively); (c) the schematic diagram for preparing PPV-N nanoparticles (PPV-N NPs, N = 0, 1, 2, 3, 4, corresponding to 0, 12, 24, 48, and 72 h' substitution time, respectively) and (d) the procedures for fingerprint development with superglue fuming followed by staining with PPV-N NPs in aqueous colloidal solution.