

Preparation of Basic Yellow Doped Nanomaterial and Its Usage in Latent Fingerprint Development

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ABSTRACT

Basic yellow has shown great application in chemical and biological field as a dye. Ethanol-based basic yellow solution is used to enhance the deposit of superglue-developed fingerprints in forensic science. However, the potential applications of basic yellow doped nanomaterials in forensic science, latent fingerprint development in particular, were still unclear. In this study, we have succeeded in trapping basic yellow in silicon dioxide-based nanomaterials, doped aerogels, using the sol-gel method. We have tested the detection for latent fingerprints left under different conditions. The results indicated that the basic yellow doped aerogels applicable for latent fingerprint development on various forensic relevant materials, including metal foil, glass, plastic, and paper, etc. The procedure of preparation and fingerprint labeling results of these new basic yellow doped nanomaterials are presented in this study.

INTRODUCTION

Silicon dioxide-based nanomaterials offer large loading capacity for various doping chemicals or molecular complexes. When compared with other sol-gel materials, aerogels represent a class of nanomaterials that are relatively easy to fabricate but with unique thermal, optical and mechanical properties for rapid sensor or device prototyping development [1-4]. Aerogels in solids are formed by controlled evaporation of the liquid in the hydro gel. When impregnated with fluorescent compounds in their nanosize cavities, the doped aerogels exhibit strong and stable fluorescence properties that are useful for the developing of ion-exchange sensors and optical devices. But the use of these fluorescently doped aerogels in forensic applications was still largely unexplored.

Basic yellow, which Molecular Formula is $C_{20}H_{20}ClN_3O_2$, is often used in chemical and biological field as a tracer dye and it is also a highly fluorescent dye

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stain which stains cyanoacrylate developed latent fingermarks. Ethanol-based basic yellow solution is also used extensively as a fluorescent dye to enhance the deposit of superglue-fumed fingermarks in forensic science. When illuminated with an ultraviolet lamp or forensic light source, latent fingermarks fluoresce highly. However, the potential applications of basic yellow doped nanomaterials in forensic science, latent fingermark detection in particular, were still unclear [5-8]. The use of basic yellow doped in silicon dioxide based nanotemplates to form stable fluorescent nanomaterials for the purpose of latent fingermark development was the main goal of this study.

The basic yellow doped TEOS composite was prepared by sol-gel method. Its detection for latent fingermarks left under different conditions was studied. The results show that the basic yellow doped TEOS composite is available for the detection of fresh fingermarks left on most non-porous surfaces, semi-porous and porous surfaces. It is better than the traditional basic yellow solution method according to its large usage and strong fluorescence.

EXPERIMENTAL

Chemicals

Basic yellow was purchased from ZSXW Reagent Company (Rugao, China). Tetraethoxysilane (TEOS) was obtained from Alfa Aesar (Ward Hill, MA, USA). Iron powder was from Mallinckrodt Baker, Inc. (Phillipsburg, NJ, USA), and ethanol was purchased from SYSXH Company (Shenyang, China). Superglue was from BCIGC (Beijing, China). All chemicals were used as received without further purification.

Preparation of Basic Yellow Doped Silicone Dioxide-based Aerogel

Basic yellow doped TEOS wet gel was prepared by the following general procedure. TEOS (5.8ml, 26.0mmol) was added to a stirred methanol solution of Basic yellow followed by a rapid addition of deionized water (1.15ml). The mixture was stirred for 1 min before being divided into 3ml aliquots in glass vials. The gels were then aged for 5 days at 25°C. After aging the robust gels were washed every 18 hrs with Basic yellow methanol solution for 2 days. After washing the gels were then dried via slow evaporation at room temperature. After 15 days Basic yellow doped silicone dioxide-based aerogel was obtained.

Preparation of Magnetic basic Yellow Doped Silicone Dioxide-based Aerogels (MBYX) Powder

The Basic yellow doped silicone dioxide-based aerogels were ground into a fine powder using a mortar. Iron powder was added to the aerogel powder with a mixing ratio of 10:1 (w/w). The mixed powder was identified as MBYX powder. The MBYX powder was kept in closet vials at room temperature for storage. The fluorescence properties of the powder were found to be stable for more than 12 months. The use of magnetic powders with a magnetic applicator offers the unique advantage of avoiding smudging and destruction of fingermarks involving non-magnetic powders.

Development of Latent Fingermarks by Magnetic Basic Yellow Doped Silicone Dioxide-based Aerogel Powder

A multitude of surface substrates were chosen for the fingerprint experiments. These include non-porous surfaces, such as aluminum foil, glass, porcelain, painted wood and plastic, a semi-porous leather surface, and some porous surfaces. Fingermarks obtained from the same donor and pressed onto different substrates were present here. Fingermarks from different donors were also tested and similar results were obtained. Fresh fingermarks were formed on various substrates using medium pressure. Labeling of fresh fingermarks was performed within 10 minutes after the fingerprint application. For studying aged fingermarks, the fresh fingermarks on selected substrates were left open to the air for 10 days or longer. All samples were stored at room temperature. Magnetic brushing technique was used for the development of fingermarks by brushing the magnetic basic yellow doped silicone dioxide based aerogel powder on the fingermarks using a magnetic applicator. The developed fingermarks were observed under long UV (365nm). All images were acquired with a 6.1 Megapixel Kodak (Easy Share Z650) digital camera.

RESULTS AND DISCUSSION

In this study, basic yellow doped silicone dioxide-based aerogel was successfully made as described in Section 2 above. Ground powder of aerogel was mixed with iron powder was identified as MBYX powder.

Fluorescent Properties of the Basic Yellow Doped Aerogel

The basic yellow doped silicone dioxide-based aerogel, which is easy to be ground into fine powder, is light yellow and translucent. The fingerprint labeled by the magnetic aerogel powder is yellowish and showed out bright fluorescence under long UV light.

Labeling of Fingermarks on Different Nonporous Substrates

The MBYX powder was able to develop fingermarks on most non-porous surfaces. The labeling efficiency depends strongly on the substrate surfaces. The fingermarks on aluminum foil (panel A), glass (panel B), leaf (panel C) and brown paper (panel D) were labeled with the magnetic powder of doped aerogel as shown in Fig.1. Here, all labeling experiments were performed on fresh fingermarks.

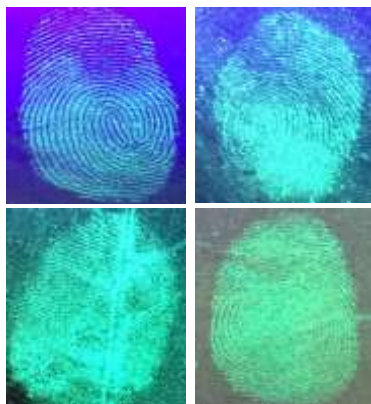


Figure 1. Fingerprint images labeled by the MBYX powder on different substrates, Aluminum foil (A), glass (B), leaf (C) and brown paper (D).

The MBYX powder appeared to be able to identify the fingerprints with reasonable details on porous and non-porous surfaces.

Effect of Fingerprint Age on the MBYX Powder Labeling

Whether or not the age of fingerprints would affect the labeling of the MBYX powder was examined. The reasonable results of 10 days aged fingerprints were obtained on both aluminum foil and glass. Useful fingerprints and identifiable fingers were found on the above substrates. Note that we have also examined fingerprints left on various surfaces for as long as 30 days. Acceptable labeling of lipid fingerprints was also observed on aluminum foil and glass.

Comparison of Fingerprints Development by Basic Yellow Doped Aerogel Powder and Basic Yellow Solution Method

Basic yellow methanol solution can be used on the superglue-fumed fingerprints to enhance the fluorescence. The MBYX powder also can be used on the fumed fingerprints. The superglue fumed fingerprints on glass were enhanced by 2% basic yellow methanol solution. The comparison result showed that the development of both basic yellow reagent and powder fluorescent almost the same.

The Stability of Fluorescence of the Labeled Fingerprints

The fluorescence properties of the basic yellow doped aerogel in storage or in the labeled fingerprints are stable for a year in our research laboratory.

CONCLUSIONS

In this study, basic yellow was successfully impregnated in silicon dioxide-based aerogel. Basic yellow in TEOS template exhibited high fluorescence intensity and labeling efficiency. The fluorescence properties of the doped gels in storage or in labeled fingerprints are stable for months in our research laboratory. The result indicates that the basic yellow doped aerogel is useful as fingerprint labeling agents due to its strong fluorescence properties and photo-stable properties. The doped aerogel was able to label all forensic relevant substrates, including aluminium foil, glass, paper, soft and hard plastic surfaces. Some deterioration in labeling was observed on aged fingerprints on glass and aluminium foil substrates.

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