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Functionalization of textiles using eco-friendly sol-gel processes

AUTHORS

Tarik AABOUB / UNIV RENNES- CNRS UMR 8029 SATIE, ECOLE NORMALE SUPÉRIEURE DE RENNES, CAMPUS DE KER LANN, BRUZ
Martinus.H.V WERTS / UNIV RENNES- CNRS UMR 8029 SATIE, ECOLE NORMALE SUPÉRIEURE DE RENNES, CAMPUS DE KER LANN, BRUZ
Aicha BOUKHRISS / REMTEX, ECOLE SUPÉRIEURE DES INDUSTRIES DU TEXTILE ET HABILLEMENT, CASABLANCA
Said GMOUH / LIMAT FACULTE DES SCIENCES BEN M'SIK, UNIVERSITE HASSAN II, CASABLANCA

PURPOSE OF THE ABSTRACT

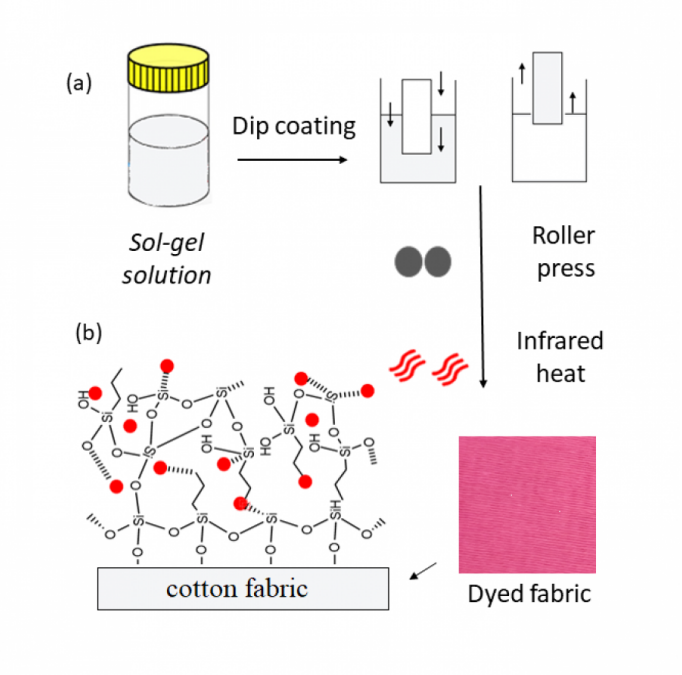
The surface functionalization of textile fibers has recently gained much interest for the production of technical and aesthetic textiles with specific properties. Textiles can undergo pre-treatment to gain new functionalities such as antibacterial character, fire-retardancy, water resistance, electrical or magnetic behavior, and so on. Many new pre-treatment processes have been developed thanks to the evolution of nano-technologies and other innovations like jet-ink printing, electrospinning, and sol-gel chemistry, in addition to conventional techniques such as screen-printing and polymer coating. Different methods are used depending on the desired functionality and the final use of the fabric: clothing, technical use, or "smart textile" applications.

In our work on functional textiles, we aimed to prepare wearable textiles with special optical effects by the pad-dry-cure method using a novel sol-gel process. This method preserves the mechanical properties of the fabric. A study of this process and its critical parameters was conducted to optimize this promising approach. We found that dyeing by the sol-gel process can be achieved at room temperature and uses fewer solvents and chemicals, making it an eco-friendly process. Additionally, the sol-gel process was employed to prepare a fluorescent textile sensitive to pH variations that can also be observed with the naked eye. This propriety is of use in versatile applications such as the detection of acid rain, body-sweat variations, and medical pads.

Furthermore, luminescent molecules were applied to textiles by the sol-gel process [1] along with polymer coating and screen printing. In most cases, fluorescent materials are used for amusement and decoration purposes, but they can also be used to mark textiles rolls as encryption against counterfeiting [2]. To this end, "invisible" fluorescent ink was developed and adjusted to be used in hand-writing pens, jet-ink printers, or rubber stamps. As an application of this ink, we printed QR codes on cotton fabric using a jet-ink printer intending to conceal encrypted pieces of information. The printed code appears only under 365nm excitation light and can be scanned to identify and decrypt the code. This invisible marking can be used by industrials to fight against counterfeiting and to protect their trademark.

In conclusion, the sol-gel process that we have developed enables the eco-friendly preparation of functional textiles with original optical properties.

FIGURES



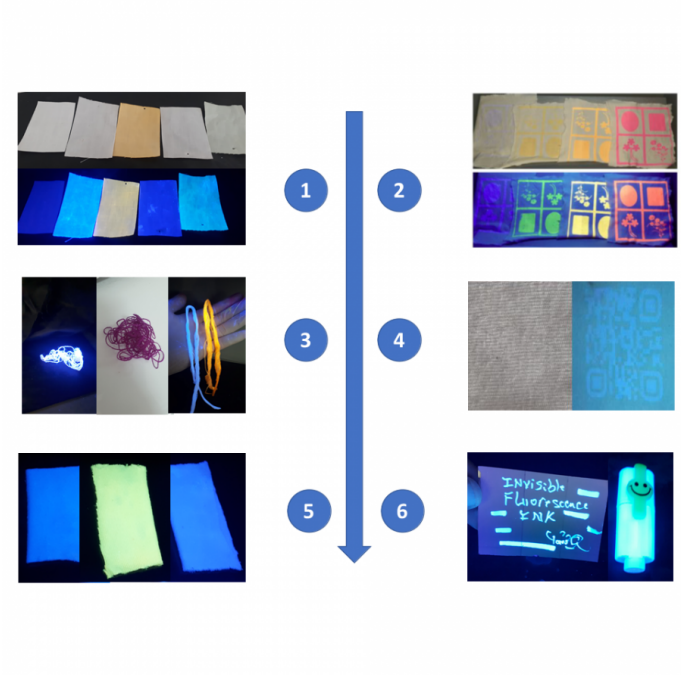


FIGURE 1

Example of a sol-gel dyeing process

(a) A textile substrate is dipped into a specially formulated sol-gel solution, mangled and dried under infrared heat. (b) The functionality is integrated into a small silicate layer covalently attached to the textile fibers.

FIGURE 2

Versatile processes for functionalizing textiles

(1) Polymer coating, (2) screen-printed textile, (3) fluorescent fibers, (4) ultraviolet QR code, (5) fluorescent textiles, (6) fluorescent ink

KEYWORDS

Sol-gel process | Textile functionalization | Eco-friendly dyeing method | Fluorescence

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