Tungsten oxide based hybrid fibers and thin films for chromogenic applications

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Abstract

A novel procedure develops to prepare tungsten oxide thin films and microfibers of the organic/inorganic blend of tungsten hexachloride and polyvinylpyrrolidone. Herein, we report on developed procedure offering several advantages over previously known procedures in the literature. First, it allows fabrication of films and microfibers, exhibiting reversible color change. Secondly, tungsten oxide as nanofibers, microfibers and thin films, fabricated via this procedure can be applied to numerous types of surfaces (e.g. paper, glass, metal and so forth) with different techniques (such as electrospinning, spin coating, droplet drawing, casting and writing ink). Lastly, these materials have large optical modulation and possess long memory with superior life-time. In overall, we believe that this procedure is a novel avenue to prepare reversible chromic materials, with superior properties.

The electrospun microfibers displayed in Figure 1 represent color alteration under UV lamp acting as a UV detector and return to their original state after a while when the UV lamp is switched off. It is worth noting that reversible fully coloration process takes about 3 minutes while the bleaching process takes about 3 hours, which indicates that the photochromic fiber has a good memory effect. More importantly, the color-cycle of the material is reversible and it retains its durability and reversibility over long period of time (i.e., several months).

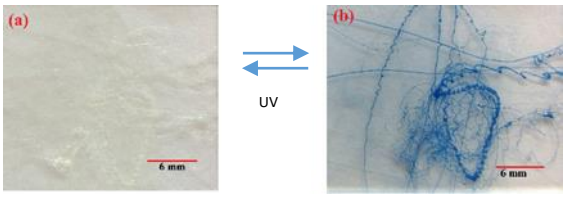


Figure 1. Electrospun microfibers of tungsten oxide. (a) as-prepared macroscopic image; (b) UV irradiated macroscopic image

Figure 2 shows the effect of UV exposure on the spin-coated thin films after 3 minutes (b). Away from direct UV light source in the darkness or in visible light, the bleaching process takes about 3 hours (a). Further studies were performed to understand the behavior of the WO_3 thin film as electrochromic device (below of Fig. 2). In order to fabricate the device, Li based electrolyte was chosen. In overall, tungsten oxide coating present new opportunities for non-destructive writable optical memory.

Their long-term stability and environmental durability leads to develop new organic/inorganic chromic materials that can be processed from microfibers to large-area solid films displaying excellent chromic properties. Another advantage of this blend is applicable to various types of substrates, such as glass, ITO glass, metal and paper. The mechanism of reversible color change is presently elucidated.

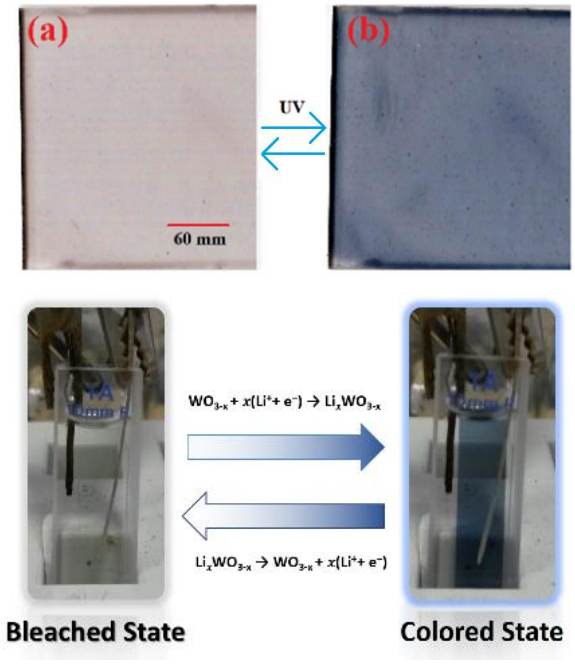


Figure 1. Photochromic and electrochromic tungsten oxide films on glass substrates