Design and development of nanostructured functional materials for sensing applications on textiles

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Nowadays the uptake of sensing devices or materials into fabric textiles is a powerful approach towards the development of the so-called, "smart textiles", wearable sensors able to react and adapt to specific external environment stimuli from their surroundings. In particular, smart textiles (also known as "e-textiles") come from a merging of electronics and textiles into fabrics, making them able to sense, compute, communicate and actuate. The inclusion of sensing functions allows the development of new systems still characterized by main textiles features such as flexibility, biocompatibility, comfort, together with mechanical resistance. Thanks to the large number of available sensing molecules and electronic devices, the introduction of the sensor technology in textiles will result in a wide range of daily life applications, such as medical and diagnostic, health care and telemedicine, fitness, sportswear and leisure, wellness, military, police and emergency services equipment, and environmental [1]. Through the integration of novel technologies, flexible supports, like textile fabrics, could be also equipped with information and power transmission capabilities, sensing functions, and an infrastructure for embedded wearable microsystems [2]. Wearable sensors, being an intermediate interface, have the potential to monitor both the wearer and the environment parameters. Since many different electronic systems can be connected to any clothing, a wearable sensor system could become more versatile, harmless and not interfering with daily activity of the wearer, and the user can also change its outfit depending on environmental changes and specific preference.

Nanotechnology can provide high durability for fabrics; in this way, the sol-gel technique or nanocomposites polymerization are promising method exploited to better control the size and shape of the hosting nanostructured 3D network as textile coating [3], and firmly bind to or include functional molecules. For this reason, smart textiles have attracted much interest for example as colorimetric sensors able to change color according to specific external stimuli, such as pH, VOC, ionic species and oxygen changes. As a main part of this vision the development of sol-gel pH sensors, based on different dyestuff and on light absorption and/or fluorescence emission, makes them useful devices in many areas, such as medical, environmental or food monitoring [4]. Several reported results show that a certain washing fastness of the obtained coating is reached in any case, and that the sensor films show excellent reproducibility, reversibility and short response times, in the specific dyes or sensing dynamic ranges [5]. Opportune functional nanomaterials, such as metal nanoparticles, nanofillers and conducting polymer nanocomposites, may be integrated into the flexible coating structure, in order to improve or to develop the desired sensing ability on coated textiles and respond to a stimulus from external optical, electrical, thermal, chemical or magnetic sources.

References

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