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Perspective

Impacts of Silver Nanowire-Based Electrodes on Electronic devices

Jay Herath*

Department of Medicine, University of British Columbia, Vancouver, Canada

DESCRIPTION

Indium tin oxide is currently the most widely used material for transparent electrodes. Silver nanowires are a promising alternative to indium tin oxide as a material for transparent electrodes due to their high electrical conductivity, transparency in the visible wavelength range, and flexibility. They are suitable for various electronic device applications such as touch panels, biosensors, and solar cells. However, the high synthesis cost and low stability to external chemical and mechanical damage of silver nanowires are important challenges that need to be addressed.

Transparent electrodes are important components in various electronic devices such as displays, solar cells, and energy harvesters. Indium tin oxide exhibits high optical transmittance and electrical conductivity, as well as excellent chemical stability, making it the dominant material system for transparent electrodes in various electronic devices. However, indium tin oxide is inherently brittle with large deformations, which limits its use in flexible/portable devices. Furthermore, indium tin oxide requires a high temperature post-annealing process to improve electrical conductivity, which is not suitable for flexible polymer-based substrates. The cost of indium is also relatively high. Therefore, there has been considerable research interest in developing alternative transparent electrode materials in recent years. Silver nanowires are cylindrical with diameters on the order of tens of nanometers and lengths on the order of micrometers. Silver nanowires can be synthesized by various methods such as chemical synthesis, electrodeposition and physical vapour deposition. Chemical synthesis methods such as the polyol reduction process are effective in producing high-quality silver nanowires with high aspect ratios. The electrical and optical properties of transparent silver nanowire electrodes are highly dependent on the aspect ratio of individual silver nanowires and the density of the deposited network. To achieve high conductivity with optical transparency, a well-leaky network of low-density silver nanowires that provides enough free space for light to pass through without strong reflection at the silver surface. Therefore, we need long and thin silver nanowires. Nanowires can be transferred. Silver nanowires have some drawbacks that need to be addressed. One of the main challenges is the high synthesis cost of silver nanowires and the lack of process scalability. Silver nanowires have low stability to external chemical and mechanical damage. Synthesis of silver nanowires is challenging because their size, shape, and morphology are difficult to control. Chemical reduction method is one of the most widely used methods for synthesizing silver nanowires. A reducing agent such as sodium borohydride or hydrazine is used to reduce silver ions in solutions such as water or ethanol. The mixture is then heated at 90°C for 3 hours. Synthesized silver nanowires are washed and collected by centrifugation or filtration.

Another method to synthesize silver nanowires is the template-assisted method. In this method, templates such as porous anodized alumina templates and polycarbonate templates are used to direct the growth of silver nanowires. In this method, the template is coated with a thin layer of silver nanowires using either a chemical reduction process or a physical vapour deposition process, followed by etching or dissolution to remove the template.

A third method to synthesize silver nanowires is electrodeposition. In this method, an electric current is used to electrodeposit silver nanowires on the electrode surface. An electrode is immersed in a solution containing silver ions and a supporting electrolyte, and an electric current is passed through the electrode to produce silver nanowires. Silver nanowires are collected by removing the electrodes from the solution. The electrodeposition process also allows us to control the size and shape of the silver nanowires by adjusting the electrodeposition conditions. Transparent silver nanowire electrodes have high optical transmission and electrical conductivity, making them suitable for use in electronic touch screens. The touch screen with silver nanowire electrodes uses silver nanowires as transparent electrodes. Various types of electrodes are used in silver nanowire-based touchscreens. A silver nanowire network is a simple system that uses only silver nanowires to form a transparent electrode. A touch panel measures the change in electrical resistance at a contact point. However, the limited

Correspondence to: Jay Herath, Department of Medicine, University of British Columbia, Vancouver, Canada, E-mail: herath123@gmail.com

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chemical stability of bare silver nanowire networks limits their industrial use. A hybrid type has been proposed to overcome the stability problem.

Indium tin oxide increases electrical conductivity and improves chemical stability. However, the brittleness of indium tin oxide reduces the mechanical flexibility of silver nanowire networks. Another strategy is to use electrodes printed with silver nanowires. Silver nanowire inks formulated for improved chemical resistance are printed on flexible substrates. The stability of silver nanowires can be tuned by the type of ink formulation. However, the cost of ink formulation is high and the minimum pattern size is in the micron range. These factors limit their use in small state-of-the-art devices. Electrodes embedded in silver nanowires possess high chemical and mechanical stability while retaining the excellent optical and electrical properties of silver nanowires. The specific technology depends on the needs of the application, such as the required transparency and conductivity, as well as the cost and durability of the touch panel.