New research shows how silver could be the key to gold-standard flexible gadgets

May 11 2016

Research published in the journals *Materials Today Communications* and *Scientific Reports* has described how silver nanowires are proving to be the ideal material for flexible, touch-screen technologies while also exploring how the material can be manipulated to tune its performance for other applications. Currently, touch screen devices mainly rely on electrodes made from indium tin oxide (ITO), a material that is expensive to source, expensive to process and very brittle.

A team from the University of Surrey, led by Professor Alan Dalton and in collaboration with M-SOLV Ltd, a touch-sensor manufacturer based in Oxford, looked to alternative materials to overcome the challenges of ITO, which is suffering from supply uncertainty. Alternative materials investigated as ITO replacements have included graphene, carbon nanotubes and random metal nanowire films. This study showed how silver nanowire films have emerged as the strongest competitor, due to transmittances and conductivities which can match and readily exceed those of ITO. This is a material that consists of wires which are over a thousand times thinner than a human hair, that form an interconnected conductive network.

Matthew Large, the first author on the research published in *Scientific Reports* described the importance of these latest results. "Our research hasn't just identified silver nanowires as a viable replacement touchscreen material, but has gone one step further in showing how a process called 'ultrasonication' can allow us to tailor performance capabilities. By applying high frequency sound energy to the material we

can manipulate how long the nanosized 'rods' of silver are. This allows us to tune how transparent or how conductive our films are, which is vital for optimising these materials for future technologies like flexible solar cells and roll-able electronic displays."

In a paper published last month in *Materials Today Communications*, the same team, showed how silver nanowires can be processed using the same laser ablation technique commonly used to manufacture ITO devices. Using this technique, the team produced a fully operating five inch multi-touch sensor, identical to those typically used in smartphone technology. They found it performed comparably to one based on ITO but used significantly less energy to produce.

"Not only does this flexible material perform very well, we have shown that it is a viable alternative to ITO in practical devices," concluded Professor Dalton. "The fact we are able to produce devices using similar methods as currently in use, but in a less energy-intensive way is an exciting step towards flexible gadgets that do not just open the door for new applications, but do so in a much greener way."

Maria Cann, a technologist from M-SOLV and first author on the Materials Today Communications paper added ""We are seeing a lot of interest from our customers in silver nanowire films as an ITO replacement in devices. This work is a really important step in establishing exactly which sensor designs can make good nanowire products. The fact that the nanowire films are processed by the same laser techniques as ITO makes the transition from ITO to nanowires really straightforward. It won't be long before we are all using nanowires in our electronic devices. "

The team, now based at the University of Sussex is now looking to develop the scalability of the process to make it more industrially viable. One limiting factor is the current cost of silver nanowires. Funded by

Innovate UK and EPSRC, the team are collaborating with M-SOLV and a graphene supplier Thomas Swan to use a nanowire and graphene combination in the electrodes to markedly reduce the cost.

More information: Matthew J. Large et al. Predicting the optoelectronic properties of nanowire films based on control of length polydispersity, *Scientific Reports* (2016). DOI: 10.1038/srep25365

Provided by University of Surrey