Byung Hee Hong
Department of Chemistry, Seoul National University, Korea
& Graphene Square Inc., Seoul National University, Korea
thoroh@mackenzie.br

Graphene for Wearable Electronics: Challenges and Opportunities

The use of graphene as a transparent electrode has already been demonstrated in a variety of flexible optoelectronic devices, including touch-screen sensors, organic light-emitting diodes and organic photovoltaic devices. The possibility of fabricating lightweight, thin and low-cost flexible electronics devices through continuous roll-to-roll processes is another important advantage of using graphene electrodes.

Despite this, considerable challenges must be overcome to integrate graphene-based transparent electrodes into commercial devices. These include the development of a low-cost, large-scale synthesis method for high-quality graphene with guaranteed uniformity and reproducibility; a defect- and residue-free transfer method that is compatible with conventional device manufacturing processes; doping processes that can assure stable, high electrical conductivity over long periods; a method to improve the environmental stability of graphene electrodes against moisture and chemicals in the air; and a method to decrease the contact resistance between electrodes and active materials.

We expect that the market for flexible electronics will become larger than that for non-flexible electronics in about 10 years. Although there are many candidates for ITO replacement — including metal meshes and silver nanowires whose sheet resistances are as low as ~10 Ω sq^{-1} at ~90% transmittance — none of them are as flexible as graphene. For example, the conducting properties of graphene can remain stable up to ~11% extension , and its initial sheet resistance persists for ~300,000 cycles at 3% bending strain , whereas a silver nanowire breaks easily at strains of less than 1%. This would be particularly important for wearable electronics that require extreme flexibility.

References

[1] Jong-Hyun Ahn & Byung Hee Hong Nature Nanotech. 9, 737-738 (2014).

Figures

Figure 1: Graphene-based multi-touch screen showing excellent flexibility (left) and possible applications in bendable or foldable mobile devices (right)1.