

Flexible Electronics

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What is Flexible electronics?

The majority of electronics is built on top of silicon (Si) as a substrate. On certain occasions, glass can be used as an alternative to silicon. By using a flexible material as substrate, such as various kinds of plastic, and fabricating electronics on it, we end up with *flexible electronics*! Will the next Samsung Galaxy or Apple iPhone use flexible materials? Maybe...

Applications

Flexible screens and sensors – Next generation smartphones and laptops?

Many smartphone and laptop manufacturers have presented concepts and working prototypes of foldable and flexible devices.

Lenovo - using advanced material and new screen technologies to create a foldable laptop screen (concept 2016)



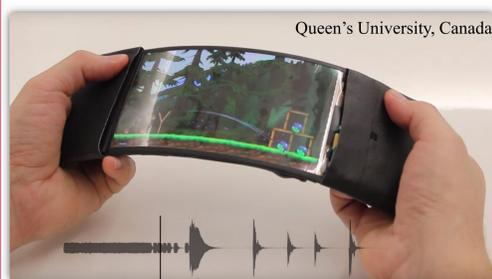
Cambridge Graphene Centre and Plastic Logic – Flexible e-ink type display using graphene electronics. (2014)

LG Display – A 810x1200 18” OLED foldable display with a reported \$1.75 billion investment. With 0.18mm thick, it’s rollable like a poster! (presented 2016).



Flexterra – A start-up comprised by physicists and chemists created a 24 mm x 30mm flexible screen for a smart “wrist band” called Wove Band. (2017)

Central Standard Timing - CST-01: A 0.8mm thick flexible wristwatch, with an e-ink (Kindle like) screen. The “world’s thinnest watch” that weighs 12g. It raised over \$1,000,000 on Kickstarter. (2013)

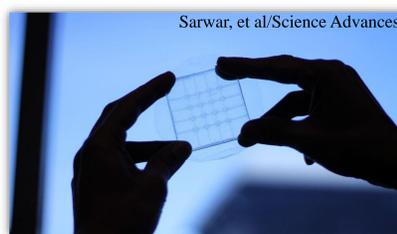


Queen’s University, Canada – ReFlex: A flexible smartphone with useful features, but also fun! Bend it to launch the birds in *Angry Birds*!! It has a 720p OLED display by LG, Android OS and sensors to “feel” the bend. (2016)

Flexible sensors

To enable flexible devices, a flexible touchscreen is needed. Also, flexible and conformable electronics find applications in wearable sensors for bio-related applications.

University of British Columbia, Canada – A 5cm x 5cm prototype flexible sensor that can detect “touch” commands while bended or stretched. (2017)

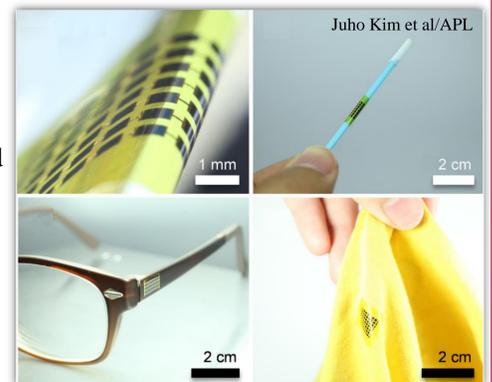


Applications

Flexible batteries and solar cells – Energy supply

Smartphones and laptops with flexible screens and flexible electronics are useless without a flexible source of energy. Batteries can be made flexible. A *greener* alternative? Flexible solar cells? Done!

Korean Universities – Flexible, ultra-thin solar cells that can be integrated to a number of devices and objects : smartwatches, clothes, bags, even glasses! (2016)



Panasonic – A flexible battery that can pass 1000 bend cycles and maintain 80% of the capacity. At 0.45 mm, it is very thin, but with a low max capacity of 60 mAh, much less than an iPhone 7 battery (~1900 mAh). (2017)

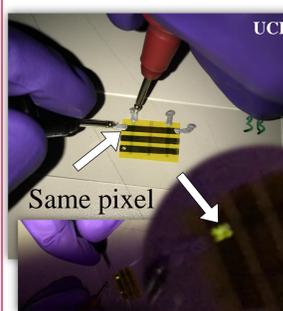
Our work for Flexible Electronics: Sensors!

Our approach to flexible sensors is “tattoo” electronics! Just like the “tattoos” found in snacks! All that is needed is just a wet cloth and the tattoo is transferred. Our driving force:

University of California-Berkley, US – All-organic sensor for pulse oximetry: Measure pulse rate and blood oxygenation by using light. Flexible substrate with two OLEDs and a detector. (2014)

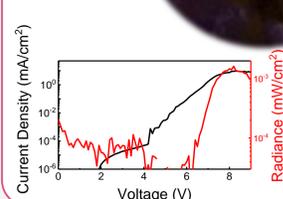


Lochner et al, Nat. Commun. 2014



University College London, London – A tattoo-able working OLEDs on commercial tattoo paper with green emission – On-going work!

For this work we used a commercial tattoo paper, some bio-compatible “plastics” (polymers) to emit the light and aluminium! The device works (not ideally, yet!!)



Further optimisations are on the way! Our (Italian) collaborators at the Centre for Micro-BioRobotics (CMBR) in IIT are developing the detection part on the same tattoo paper and hopefully we can obtain a fully organic flexible OLED-detection system.

Conclusions

Flexible electronics are a major market, with a projected worth of up to \$73.4 billion by 2027 for the printed, flexible and organic electronics markets, receiving a lot of investments from over 3000 companies and organisations ranging from multinational companies, such as LG and Samsung, to innovative start-ups and leading Universities around the world.

Acknowledgements

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