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Optically transparent cellulose nanopaper for electronic devices

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Cellulose nanofibers are the main component of plant cell walls, and thus they are probably one of the most ubiquitous and abundant polymers on the planet. We have re-invented paper by using 15 nm wide cellulose nanofibers [1]. This re-invented “nanopaper” has high transparency like a glass, high thermal durability around 200 C, incredible low thermal expansion (5-10 ppm/K), and high foldability like a traditional paper. The nanopaper is therefore perfectly consistent with the requirements of substrates in printed electronics, instead of fragile thin glass or thermal sensitive plastic films. Recently we reported some nanopaper applications in electronic devices of “nanopaper transistor [2]”, “transparent conductive nanopaper using silver nanowires or carbon nanotubes [3]”, “foldable nanopaper antenna [4]”, “electrical conductive lines on nanopaper [5]”, “nanopaper solar cell”, “nanopaper resistance random access memory” and so on (Fig. 1).

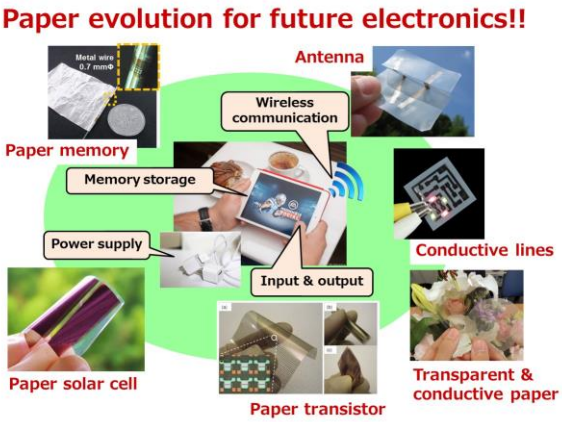

Fig. 1 Advanced devices using cellulose nanopaper

To fabricate these various devices, we had to develop many kinds of nanopapers in each application. For example, nanopaper characteristics depend on cellulose sources, nanofibrilation procedures, and drying of nanofiber suspensions. Thus, the author will present key parameters in nanopaper fabrications and their quality for electronics applications. The author believes that these findings illuminate a promising route for the realization of foldable origami electronics, which will be of great interest for a variety of applications, including wearable computers, foldable electronics, and healthcare sensors.

[1] M. Nogi et al., Adv. Mater. (2009) DOI: 10.1002/adma.200803174

[2] Y. Fujisaki et al., Adv. Fun. Mater. (2013) DOI: 10.1002/adfm.20130302

[3] H. Koga et al., NPG Asia Mater. (2014) DOI: 10.1038/am.2014.9

[4] M. Nogi et al., Nanoscale (2013) DOI: 10.1039/c3nr00231d

[5] M. Hsieh et al., Nanoscale (2013) DOI:10.1039/C3NR01951A