

**【Grant-in-Aid for Scientific Research (S)】**  
**Science and Engineering (Engineering)**



**Title of Project : Nonvolatile Resistive Memory Using Cellulose Nanopaper**

Masaya Nogi  
(Osaka University, The Institute of Scientific and Industrial Research, Associate professor)

Research Project Number : 26220908 Researcher Number : 80379031

Research Area : Materials

Keyword : Functional Polymer, Cellulose Nanofiber

**【Purpose and Background of the Research】**

Electronic devices should be manufactured by low energy consumption processes to realize a sustainable and clean society. Recently, we have proposed “paper electronics” using cellulose nanopaper. In 2009, we invented cellulose nanopaper using cellulose nanofibers only. Paper electronics could be manufactured on foldable nanopaper using high-volume and high-speed printing technology. Moreover, obtained paper devices enhanced lightweight and rollability enough to carry them in your bag. Therefore, the cellulose nanopaper is one of the best candidates for the future electronic components.

To realize the paper electronics, we have already developed some paper device components (Fig. 1). For example, highly conductive lines on nanopaper electrically connect devices components, and transparent conductive paper and paper transistor are key components for touch panel and display devices. Paper antenna will realize wireless communication by a transmission and reception of information signals. Moreover, electric power for the devices will be supplied from paper solar cell. Due to these achievements, paper electronics will be completed by only one device components, which is a memory device component.

**For Origami electronics**

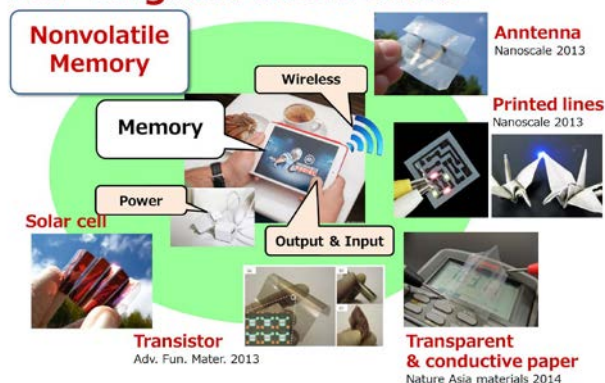


Fig. 1 Previous researches and this proposal

**【Research Methods】**

In this project, we developed nonvolatile random access memory (ReRAM) using cellulose nanopaper. In particular, we will discuss about the nanofilament growth mechanism inside a nanopaper as an insulating layer. Thus, the principal investigator of Dr. Nogi (ISIR, Osaka-univ.) and co-investigators of Dr. Yanagida, Dr. Nagashima, and Dr. Koga (ISIR, Osaka-univ.) et al. will study the following four topics.

1. Growth mechanism of conductive filament at an insulating layer.
2. Developments of key technologies (substrates, electrodes, insulator) in nanopaper ReRAM
3. Developments of interconnecting technologies for nanopaper ReRAM
4. Developments of nanopaper ReRAM

**【Expected Research Achievements and Scientific Significance】**

The paper memory is the last components to realize lightweight and foldable paper electronics. We hope paper electronics will open a door to realize a low-carbon society with our fruitful daily life.

**【Publications Relevant to the Project】**

- H. Koga, M. Nogi et al., NPG Asia Mater., 6 (2014) e93, doi:10.1038/am.2014.9  
Y. Fujisaki *et al.* Adv. Funct. Mater., 24 (2014) 1657–1663, DOI: 10.1002/adfm.20130302  
M. Nogi et al. Nanoscale, 5 (2013) 4395-4399, DOI: 10.1039/c3nr00231d  
M. Hsieh *et al.*, Nanoscale, 5 (2013) 9289-9295, DOI:10.1039/C3NR01951A  
M. Nogi et al., Adv. Mater., 21(2009)1595-1598, DOI: 10.1002/adma.200803174

**【Term of Project】** FY2014-2018

**【Budget Allocation】** 135,400 Thousand Yen

**【Homepage Address and Other Contact Information】**

<http://www.nogimasaya.com/>  
nogi@eco.sanken.osaka-u.ac.jp