

A Breathable and Washable Graphene-cellulose E-paper for Wearable Electronics

Huiqing Zhang^{a,b,c}, Rongyan He^{b,c}, Hao Liu^{b,c}, Zedong Li^{b,c}, Xiongwen Zhang^{a,b}, Feng Xu^{b,c}

a MOE Key Laboratory of Thermo-Fluid Science and Engineering, School of Energy & Power Engineering, Xi'an Jiaotong University, Xi'an 710049, P.R. China (848411556@qq.com)

b The Key Laboratory of Biomedical Information Engineering of Ministry of Education, School of Life Science and Technology, Xi'an Jiaotong University, Xi'an 710049, P.R. China (540402050@qq.com)

c Bioinspired Engineering and Biomechanics Center (BEBC), Xi'an Jiaotong University, Xi'an 710049, P.R. China (540402050@qq.com)

Abstract

Wearable electronics has recently found widespread applications in biomedical fields, where substrate materials with breathable and washable features are of great importance for the practical applications. In this work, we developed a breathable and washable graphene-cellulose e-paper as substrate material for wearable electronics through a facile and scalable paradigm. We directly mixed hydrophilic graphene oxide with hydrophilic cellulose fibers during papermaking to ensure that graphene nanosheets uniformly spread all over the paper matrix during papermaking, thus providing extraordinary electrical conductivity after thermal reduction of graphene oxide. The unique 3D hierarchical porous structure of the e-paper enables excellent breathability and provides a comfortable implementation on skin surface even for long-term monitoring as demonstrated in rabbit skin *in vivo*. Besides, this graphene-cellulose e-paper can endure long-time soaking in water and multiple washing-drying cycles with maintained structural property and functional performance. The e-paper has also been demonstrated to be feasible as a human motion detector, even after soaking or washing. The developed graphene-cellulose e-paper holds great promise for versatile applications in advanced wearable electronics for monitoring human healthcare.