長崎大学第３期中期目標・中期計画重点研究課題「次世代エネルギー関連技術に向けた革新的物質科学研究拠点」第４回講演会

グリーンシステム創成科学専攻平成 29 年度国際セミナー

第６８３回化学・物質工学セミナー

この度，長崎大学第３期中期目標・中期計画重点研究課題の第４回講演会を，グリーンシステム創成科学専攻国際セミナーならびに第６８３回化学・物質工学セミナーも兼ねて企画いたしました。万障お繰り合わせの上，ご参加下さい。

記

日時：平成 29 年 11 月 13 日（月）　10：30 ～ 12：00

場所：長崎大学文教キャンパス　総合教育研究棟 2F　多目的ホール

Integration of high performance micro-supercapacitors onto rigid and flexible substrates

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Abstract

The constant development of wireless sensors networks and wearable applications needs to be supported by the fabrication of miniaturized energy storage devices. Electrochemical double layer capacitors (EDLCs), or supercapacitors, are a good candidate to handle energy recovery and harvesting in a short time, as they store the charge via reversible ion adsorption at the surface of high surface area carbons. However, the standard procedure involved in the preparation of supercapacitors electrodes, where the carbon powder is mixed with a binder to prepare film electrodes, does not fit with the requirements of the semi-conductor industry.

To overcome this technological barrier, two strategies were adopted in this work. First, carbide-derived carbons (CDCs) were prepared from the chlorination of patterned titanium carbide interdigitated electrodes sputtered on silicon wafers. The extraction of the metallic atoms through reaction with a chlorine gas led to microporous with a very narrow pore size distribution, which could be fine-tuned at the sub-nanometer scale with the parameters. Since higher energy density could be reached using pseudocapacitive materials, laser writing was performed to design RuO_2-based micro-supercapacitors, offering short time engineering under ambient at room temperature. Commercial $RuO_2 \cdot xH_2O$ was successfully deposited onto flexible polyimide substrate (Kapton^{TM}) without any current collector. The addition of commercial $HAuCl_4 \cdot 3H_2O$ brought better adherence of the deposit.

The as-prepared CDC-based micro-supercapacitors delivered interesting capacitance values of 13 $mF \cdot cm^{-2}$ / 96 $F \cdot cm^{-3}$ in 1M H_2SO_4. Another strategy to design high performance micro-supercapacitors is to use pseudocapacitive materials, which store energy by fast faradic reactions occurring at the outer surface of the electrodes, leading to higher energy densities. Among pseudo-capacitive materials, RuO_2 exhibits high theoretical gravimetric capacitance (1200 $F \cdot g^{-1}$) and its coast is no longer an issue as small amounts of active materials are needed for micro-electrodes (less than 1 $mg \cdot cm^{-2}$). As a result, flexible micro-supercapacitors exhibited values up to 27 $mF \cdot cm^{-2}$ in 1M H_2SO_4. Aside, different geometries could be used for the RuO_2 / Au electrodes, offering a good alternative to provide energy for wearable applications.

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