The Nanostructured and Functionalized Graphene for Applications on Sensing, Optronics and Energy Storage

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Since the discovery of graphene, it has attracted highly interest due to its unique chemical and physical properties such as superior thermal conductivity, highly specific surface area, and electrical conductivity. These tremendous properties make graphene a promising material for the applications in electronics, sensors, and energy storage devices. In this talk, three main topics will be included: (1) the current developed approaches for cost-effective synthesis of high crstalline graphene will be conducted. Especially the insight to large-scaled and continuous production of CVD grown graphene film.[1-3] (2) The unique electronic and optical properties of funcationalized graphene were found to be tailored by heteroatomic doping(B-, N-, F-, O- etc) and surface decoration(Au, Ag nanoparticles or nanowire), their applications on transistors and transparent conductive film will be detailed. [4-6] (3) The preparations of nanostructured graphene and their applications. At first, we demonstrate the largest (up to 1.5 mm) suspended graphene film and their applications on capacitive pressure sensor, which shows supeeriror sensing performacne than nowadays membrance materials[1]. Second, we present an all-screen-printable method for fabricating all-solid and flexible micro supercapacitors(MSCs) by rational designed composite electrodes of electrochemical exfoliated (EC-)graphene and long single-walled carbon nanotubes(CNTs). The systematic investigations are carried out on various electrode patterns, thickness, and the ratio of graphene/CNTs. A specific areal capacitance of 11.8 mF/cm2 and specific stack capacitance of 118 F/cm3 (at 5 mV/s)was achieved, which was superior to most of reported MSCs. Moreover, it exhibits a high cycling stability of 98% retention after 1000 cycles. It shows 90.2% capacitance sustention when the bending angle up to 180o, indicating excellent mechanical flexibility and operation stability. The extracted energy and power density of 16.4 mWh/cm3 and 294.8 W/cm3, which was, to our best knowledge, the highest performance for ultra-thin(<5 um) MSCs. This work provides a scalable and cost-effective method to produce solid-state MSCs with high energy density.

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