CP 8

CONCEPT PAPER

for KIER International Cooperation project

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Title	**Novel dimension-controlled materials for combined energy conversion and energy storage devices**			
Description	○ *Barriers to tackle:* Integration of energy harvesting and storage devices is considered to be one of the most important energy-related technologies because of the possibility of replacing batteries or at least extending the lifetime of a battery. Moreover, in order to develop on-chip, flexible, wearable energy conversion and energy storage devices, new thin-film and especially dimension-controlled materials are desired. The energy harvesting/conversion components must also be directly integrated with energy storage modules for optimal portability. Scaling photovoltaic systems down to the low-dimensional limit while retaining efficiency requires understanding of the mechanisms of photo-induced charge separation and charge transport within semiconductor layers to conducting electrodes that deliver the charges to miniaturized storage systems like ultra-thin supercapacitors and batteries. This proposed work is aimed at synthesizing novel dimension-controlled materials (0D, 1D, 2D, and 3D), identifying their mechanisms of energy conversion and charge transport, and matching the power output of these materials to suitable charge storage devices. ○ *Strategy to solve:* Gas-phase and/or solution-phase synthesis approach to synthesize dimension-controlled nanomaterials will be used to fabricate on-chip devices for charge transport measurements. Cross-sectional transmission electron microscopy (TEM) will be used for structural characterization of the dimension-controlled nanomaterials. Variable temperature conductivity and current–voltage response in light and dark conditions will be measured to correlate composition and electronic structure with photovoltaic response. Cyclic voltammetry and in situ electrochemical transmission electron microscopy will be used to evaluate performance of a variety of electrochemical energy storage devices based on low-dimensional materials (graphene, metal oxides/chalcogenides/halides layers, carbon nanotubes, silicon nanowires etc.) and identify the system that leads to optimal impedance matching with the photovoltaic system.			
Outcomes*	○ Synthesis and structural characterization of novel dimension-controlled nanomaterials ○ Detailed mechanistic studies of photo-induced charge separation and transport in dimension-controlled nanomaterials ○ Evaluation of electrochemical performance of ultra-thin supercapacitor or battery schemes based on low-dimensional materials. ○ 2 publications in peer-reviewed journals and/or patents.			