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Designed Synthesis and Assembly of Inorganic Nanomaterials or Energy and Soft-Electronics Applications

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Abstract: Over the last 20 years, our laboratory has focused on the designed chemical synthesis, assembly and applications of uniform -sized nanocrystals. Especially, we developed a novel generalized procedure, called as "heat-up process" for the direct synthesis of uniform-sized nanocrystals of many metals, oxides, and chalcogenides.

Recently we have focused on the architecture engineering of inorganic nanomaterials for their applications to fuel cell electrocatalysis, lithium ion battery, and photocatalysis. We present a synthesis of highly durable and active electrocatalysts based on ordered fct-PtFe nanoparticles for oxygen reduction reaction electrocatalysts for fuel cells. We report on the design and synthesis of highly active and stable Co-N4(O) moiety incorporated in nitrogen-doped graphene (Co1-NG(O)) that exhibits a record-high kinetic current density and mass activity with unprecedented stability (>110 h) for electrochemical hydrogen peroxide (H2O2) production. We report on the design and synthesis of highly active TiO2 photocatalysts incorporated with site-specific single copper atoms (Cu/TiO2) that exhibit reversible and cooperative photoactivation process, and enhancement of photocatalytic hydrogen generation activity. We synthesized multigrain nanocrystals consisting of Co3O4 nanocube cores and Mn3O4 shells. At the sharp edges of the Co3O4 nanocubes, we observed that tilt boundaries of the Mn3O4 grains exist in the form of disclinations, and we obtained a correlation between the defects and the resulting electrocatalytic behavior for the oxygen reduction reaction.

We fabricated ultraflexible and/or stretchable electronic and optoelectronic devices integrated with various functional nanomaterials and their applications to wearable and implantable medical and healthcare devices. We introduced electromechanical cardioplasty using an epicardial mesh made of electrically conductive and elastic Ag/Au nanowire-rubber composite material to resemble the innate cardiac tissue and confer cardiac conduction system function. We fabricated highly conductive and elastic nanomembrane for skin electronics. We demonstrated a wearable red-green-blue (RGB) colloidal quantum dot light-emitting diode (QD LED) array with high resolution using a novel intaglio transfer printing technique. We also reported transparent QD LEDs with extremely high luminance and transmittance. We reported a novel device design and fabrication method using metal-based etch-stop layers and a laser-assisted patterning for 3D foldable quantum dot light-emitting diodes (QLEDs).

Biography: Taeghwan Hyeon received his B. S. (1987) and M. S. (1989) in Chemistry from Seoul National University (SNU), Korea. He obtained his Ph.D. in Chemistry from U. Illinois at Urbana-Champaign (1996), and conducted one-year postdoctoral research at the Catalysis Center of Northwestern University. Since he joined the faculty of the School of Chemical and Biological Engineering of Seoul National University in 1997, he has focused on the **synthesis and applications of uniform-sized nanoparticles and related nanostructured materials**, and published > 400 papers in prominent international journals (> 65,000 citations and h-index of > 128). He is a SNU Distinguished Professor. In September 2020, he was selected as **2020 Citation Laureate** (known as Nobel Prize watch list) in Chemistry by Clarivate Analytics/Web of Science. In 2011, he was selected as "***Top 100 Chemists***" of the decade by *UNESCO&IUPAC*. From 2014 to 2020, he has been chosen as "**Highly Cited Researcher**" in both chemistry and materials science areas by Clarivate Analytics. Since 2012, he has been serving as a Director of Center for Nanoparticle Research of Institute for Basic Science (IBS). He is Fellow of Royal Society of Chemistry (RSC) and Materials Research Society (MRS). He received many awards including the Korea S&T Award from the Korean President (2016), Hoam Prize (2012, Samsung Hoam Foundation), POSCO-T. J. Park Award (2008), and the IUVSTA Prize for Technology (International Union for Vacuum Science, Technique and Applications, 2016). From 2010 to 2020, he served as an ***Associate Editor of Journal of the American Chemical Society.*** He has been serving as editorial (advisory) board members of *ACS Central Science*, *Advanced Materials*, *Nano Today*, and *Small*.

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