**Phase Engineering of Nanomaterials (PEN)**

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**Abstract**

In this talk, I will summarize the recent researches on the phase engineering of nanomaterials (PEN) in my group. In particular, we focus on the rational design and synthesis of novel nanomaterials with unconventional phases for various promising applications. For example, by using wet-chemical methods, for the first time, we have successfully synthesized the hexagonal-close packed (*hcp*) Au nanosheets, 4H hexagonal Au nanoribbons, crystal-phase heterostructured 4H/*fcc* and *fcc*/2H/*fcc* Au nanorods, the epitaxial growth of metal nanostructures with unconventional crystal phases on the aforementioned Au nanostructures, and amorphous/crystalline hetero-phase Pd nanosheets. In addition, by using gas-solid reactions, metastable 1T'-phase group VI transition metal dichalcogenides (TMDs), including WS2, WSe2, MoS2, MoSe2, WS2*x*Se2(1-*x*) and MoS2*x*Se2(1-*x*) have been prepared. Moreover, the phase transformation of TMDs during our developed electrochemical Li-intercalation method has also be observed. Impressively, the lithiation-induced amorphization of Pd3P2S8 has been achieved. Currently, my group focuses on the (crystal) phase-dependent physicochemical properties and applications in catalysis, surface enhanced Raman scattering, waveguide, photothermal therapy, chemical and biosensing, clean energy, *etc.*, which we believe are quite unique and very important not only in fundamental studies, but also in practical applications. Importantly, the concepts of phase engineering of nanomaterials (PEN), crystal-phase heterostructures, and hetero-phase nanomaterials are proposed.

**Keywords:** Noble metal nanomaterials; Transition metal dichalcogenides; Crystal phases; Unconventional phases; Amorphous phase; Phase engineering of nanomaterials (PEN); Crystal-phase heterostructures; Hetero-phase nanomaterials

**Brief CV**

Dr. Hua Zhang obtained his B.S. and M.S. degrees at Nanjing University in China in 1992 and 1995, respectively, and completed his Ph.D. with Prof. Zhongfan Liu at Peking University in China in July 1998. He joined Prof. Frans C. De Schryver’s group at Katholieke Universiteit Leuven (KULeuven) in Belgium as a Research Associate in January 1999. Then he moved to Prof. Chad A. Mirkin’s group at Northwestern University as a Postdoctoral Fellow in July 2001. He started to work at NanoInk Inc. (USA) as a Research Scientist/Chemist in August 2003. After that, he worked as a Senior Research Scientist at Institute of Bioengineering and Nanotechnology in Singapore from November 2005 to July 2006. Then he joined the School of Materials Science and Engineering in Nanyang Technological University (NTU) as an Assistant Professor. He was promoted to a tenured Associate Professor on March 1, 2011, and Full Professor on Sept. 1, 2013. In 2019, he joined the Department of Chemistry in City University of Hong Kong as a Chair Professor (Herman Hu Chair Professor of Nanomaterials).

He has published **5** invited book chapters, **74** patent applications (including **8 granted US patents** and **1 Singapore patent**), and over **490** papers, among which **294** papers (> 60%) were published in **IF>10** journals. Some of his papers have been published in ***Science*** (1), ***Nat. Chem.*** (5), ***Nat. Mater.*** (1), ***Nat. Catal.*** (1), ***Nat. Rev. Mater.*** (2), ***Nat. Commun.*** (10), ***Sci. Adv.*** (1), ***Nat. Protocols*** (1), ***Chem. Rev.*** (2), ***Chem. Soc. Rev.*** (13), ***Acc. Chem. Res.*** (2), ***J. Am. Chem. Soc.*** (17), ***Angew. Chem. Int. Ed.*** (28), ***Adv. Mater.*** (57), ***Energy Environ. Sci*** (12), ***Chem*** (1), ***Mater. Today*** (1), ***Adv. Energy Mater.*** (8), ***ACS Nano*** (31), ***Nano Lett.*** (14), ***Adv. Funct. Mater.*** (4), ***Nano Energy*** (5), ***Mater. Horizons*** (2), ***Nat. Sci. Rev.*** (3), ***ACS Catal.*** (1), ***Small*** (68), ***J. Mater. Chem. A*** (4), ***Biomater.*** (1), ***Chem. Mater.*** (2), ***J. Mater. Chem.*** (9),*etc.* Until *17 Jan. 2020*, the total cited times are over **69,300** with H-index of **127** (*Web of Science*), and over **81,700** with H-index of **137** (*Google Scholar*). He has been invited to give more than **300** Plenary, Keynote or Invited Talks in international conferences, universities and institutes, and served as the Session Chair. He has organized several tens of international conferences and served as the Symposium Chair or Conference Co-Chair.

He is one of three Chairmen of the Editorial Board of ***ChemNanoMat*** (2015-), sits on the Advisory Board of ***Chem. Soc. Rev.*** (2012-), ***Materials Chemistry Frontiers*** (2016-), ***Matter*** (2019-), ***Nanoscale*** (2012-), ***Nanoscale Horizons*** (2015-) and ***NPG Asia Materials*** (2018-), the Editorial Advisory Board of ***ACS Nano***(2014-), ***ACS Appl. Mater. Interfaces*** (2014-), ***Advanced Materials*** (2019-), ***Advanced Functional Materials*** (2018-), ***Chem. Mater.***(2014-), ***Nanofabrication*** (2012-) and ***Small*** (2012-), the Editorial Board of ***ACS Omega*** (2016-), ***Applied Materials Today*** (2015-), ***Carbon*** (2013-), ***CHEM*** (2016-), ***Chinese Science Bulletin*** (2014-), ***Energy Storage Materials*** (2015-), ***EnergyChem*** (2018-), ***Graphene Technology*** (2016-), ***Materials Today Energy*** (2016-), ***NANO*** (2007-), ***npj 2D Materials and Applications*** (2016-) and ***Science China Materials*** (2014-), the International Advisory Board of ***Chemistry – An Asian Journal*** (2018-), the International Advisory Board of ***Materials Research Express*** (2014-2016) and the the International Editorial Board of ***ChemPlusChem*** (2012-2015), and the Scientific Advisory Board of ***Small Methods*** (2017-). He is also one of the members of the Advisory Committee of ***IOP Asia-Pacific*** (2010-). In **2015**, he was elected as an ***Academician*** of the Asia Pacific Academy of Materials (APAM). In Nov. **2014**, he was elected as a ***Fellow of the Royal Society of*** ***Chemistry*** (*FRSC*). In **2016**, he was listed in the top 300 most cited researchers in the field of materials science and engineering (Elsevier Scopus). In **2015-2019**, he was listed in the "*Highly Cited Researchers*" in *Chemistry* and *Materials Science* (Thomson Reuters). In **2015**, he was listed as **one of 19** “*Hottest Researchers of Today*” in the world in the *World’s Most Influential Scientific Minds 2015* (Thomson Reuters, **2015**). In **2014**, he was listed in the "*Highly Cited Researchers 2014*" in *Materials Science*, and also listed as **one of 17** “*Hottest Researchers of Today*” and **No. 1** in *Materials and More* in the world in the *World’s Most Influential Scientific Minds 2014* (Thomson Reuters, **2014**). Moreover, he got the *Young Investigator Award* (Young Giants of Nanoscience **2016**, Hong Kong), *Vice-Chancellor’s International Scholar Award* (University of Wollongong, Australia, **2016**), *ACS Nano Lectureship Award* (**2015**), *World Cultural Council (WCC) Special Recognition Award* (**2013**), the *ONASSIA Foundation Lectureship* (Greece, **2013**), *Asian Rising Stars* (15th Asian Chemical Congress, **2013**), *SMALL Young Innovator Award* (Wiley-VCH, **2012**) and *Nanyang Award for Research Excellence* (**2011**).

Dr. Zhang’s research is highly interdisciplinary. His current research interests focus on the phase engineering of nanomaterials (PEN) and controlled epitaxial growth of heterostructures, including the synthesis of ultrathin two-dimensional nanomaterials (e.g. metal nanosheets, graphene, metal dichalcogenides, metal-organic frameworks, covalent organic frameworks, etc.), novel metallic and semiconducting nanomaterials, novel amorphous nanomaterials and their hybrid composites, for various applications such as catalysis, clean energy, (opto-)electronic devices, nano- and biosensors, and water remediation*.*

phase engineering of nanomaterials (PEN) and controlled epitaxial growth of heterostructures, including the synthesis of 2D, unusual crystal-phase and amorphous nanomaterials, for applications in catalysis, clean energy, (opto-)electronic devices, nano- and biosensors, and water remediation*.*