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3rd World Congress and Expo on

# Graphene & 2D Materials

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## Nai-Chang Yeh

*California Institute of Technology,USA*

## Exploring Novel Quantum States and Quantum Degrees of Freedom in Two-Dimensional van der Waals Materials

Recent advances in nanofabrication technology and the development of two-dimensional (2D) crystals and heterostructures/interfaces that are based on van der Waals (vdW) materials have enabled new possibilities to explore novel quantum states and to manipulate different quantum degrees of freedom (e.g., spin, valley, symmetry, topology, etc.) in materials. We have developed scalable fabrication techniques to synthesize high-quality vdW materials by PECVD methods for graphene and graphene nanoribbons, and by CVD methods for insulating hexagonal boron nitride (h-BN), semiconducting transition metal dichalcogenides (TMDCs), and heterostructures of graphene, h-BN and TMDCs. By placing nearly strain-free, PECVD-grown monolayer graphene and monolayer h-BN on top of arrays of lithographically fabricated nanostructures, we are able to perform nanoscale strain engineering that results in giant pseudo-magnetic fields (up to 103 ~ 104 Tesla), strong valley polarization, and topological channels for protected valley-polarized propagation as manifested by scanning tunneling spectroscopic (STS) studies and corroborated by tight-binding calculations and molecular dynamics simulations. We have also synthesized monolayer single crystalline WS2 semiconductors with varying p- and n-type domains that exhibit asymmetric circularly polarized photoluminescence and imply topological channels along the domain boundaries for protected valley- and spin-polarized propagation. We have further carried out experimental investigations by means of STS and electrical transport studies under circularly polarized light in order to eludicate the effect of valley polarization on the electronic density of states and the spin degrees of freedom. Implications of our findings from these 2D vdW materials on potential applications to valleytronics, optoelectronics and spintronics will be discussed.

### Biography

Nai-Chang Yeh is currently the Fletcher Jones Foundation Co-Director of the Kavli Nanoscience Institute and Professor of Physics at the California Institute of Technology. She received her B.Sc. degree in physics from National Taiwan University and Ph.D. degree in physics from the Massachusetts Institute of Technology. Her principal research field is experimental condensed matter physics, with special emphasis on topics of correlated electrons, topological materials, low-dimensional systems, spintronics, nanoscience and nanotechnology, energy research, and precise measurements using superconducting technology. She has published over 135 papers in refereed journals, coauthored a book on high-temperature superconductivity, and authored a book of autobiography.

ncyeh@caltech.edu

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