



Hybridized phonons and electronic insulating states in carbon nanotubes & electric polarization switching in multilayer graphene



Prof. ZHAO Sihan

School of Physics, Zhejiang Key Laboratory of Micro-Nano Quantum Chips and Quantum Control

State Key Laboratory of Silicon and Advanced Semiconductor Materials
Zhejiang University

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Abstract

Low-dimensional crystalline graphitic materials such as one-dimensional (1D) carbon nanotubes and two-dimensional (2D) multilayer graphene are fascinating material platforms to explore emergent physical phenomena as they feature superb material quality and are highly tunable by van der Waals interface engineering and external fields. In this talk, I will present our recent efforts to explore emergent phononic, electronic, and polarization switching in these systems. First, I will show that novel phonon modes with strongly hybridized character can arise in double-walled carbon nanotubes (DWNTs) [1]. In these concentric systems, Raman-inactive acoustic phonon modes residing in different carbon shells hybridize strongly, giving rise to pronounced Raman-active modes. Next, I will demonstrate that moiré-engineered electronic insulating states with gate-tunable fillings can emerge in a 1D moiré superlattice, realized by crystallographically aligning an armchair SWNT with a two-dimensional hexagonal boron nitride (hBN) substrate [2]. In these lattice-aligned mixed-dimensional heterostructures, pronounced insulating states are observed at the charge neutrality point (CNP), as well as at full and half moiré fillings at low temperatures. Finally, I will present the direct imaging of electric polarization switching in tetralayer graphene, thinnest possible multilayer graphene that can host polar stacking orders [3]. This is achieved by conducting a gate-tunable scanning near-field optical microscopy (SNOM), in which we show the switching process can be realized by both electric field and mechanical force.

Biography

Dr. Sihan Zhao received his doctor degree from Nagoya University, Japan, in Dec. 2015. He then became a postdoctoral researcher, working with Prof. Feng Wang, at UC Berkeley. Since 2021, he become a faculty member in School of Physics, Zhejiang University. Dr. Sihan Zhao have been studying the fundamental optical and electrical transport properties in systems such as carbon nanotubes and graphene. He has published more than 40 papers in journals such as Nature, Physical Review Letters, Nature Communications, Nano Letters, etc., with more than 4,800 total citations. He has obtained funding supports from National Key R&D Program of China, National Natural Science Foundation of China, Zhejiang Provincial Natural Science Foundation of China, etc.

*** ALL ARE WELCOME ***

For enquiries, please contact Ms. Joyce Chan, Department of Biomedical Engineering at 3943 8278