

관측에서 제어로: 나노스케일 엑시톤과 에너지 변환

From Observation to Control: Nanoscale Excitons and Energy Conversion

Energy conversion processes in condensed matter systems are often described through macroscopic responses such as light emission, charge generation, or heat dissipation. At the nanoscale, however, these phenomena originate from the formation and evolution of localized excited states. Among them, excitons play a key role as intermediate states that connect electronic, vibrational, and optical degrees of freedom. Understanding how excitons emerge and evolve at molecular and interfacial scales is therefore essential for revealing the microscopic mechanisms of energy conversion.

Recent advances in nanoscale spectroscopy have made it possible to access these processes with unprecedented spatial and energy resolution. By combining scanning probe techniques with optical and electronic excitation pathways, individual molecules and nanostructures can be investigated and their local excitonic states directly resolved. These studies show that nanoscale excitons are strongly influenced by their local environment, including electronic structure, dielectric screening, vibrational coupling, and interfacial geometry.

Beyond observation, emerging experimental approaches now enable the manipulation of excitonic processes through localized excitation, controlled charge injection, and plasmonic field confinement. In this talk, I will discuss how nanoscale spectroscopic methods allow a transition from observing excitonic phenomena to actively controlling them, providing new insights into the fundamental mechanisms of energy conversion at molecular and interfacial scales.