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Tuning Fullerene Electronic Properties: From Single Molecules to Extended Monolayers

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Fullerenes provide powerful building blocks for creating nanostructures with unique electronic properties due to their flexible electronic structure. This behavior arises through a combination of molecular energy levels, intramolecular Coulomb forces, electron-phonon coupling, and local charging. When molecules are placed at an interface, substrate charge transfer and screening effects also play an important role. We have used cryogenic scanning tunneling spectroscopy to examine the interplay of these factors in determining molecular electronic structure from the single molecule regime all the way up to the full monolayer regime. We find that it is possible to reversibly change the charge state of individual fullerenes through single-atom doping, and we have examined how molecular electronic structure is influenced by extended monolayer formation and surface screening effects. We observe strong variations in local molecular electronic structure due to charge doping, and in local electron-phonon coupling due to fullerene composition.