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Vibrational spectroscopy of chlorinated and dechlorinated graphene layers

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Graphene, a two-dimensional material composed of a single layer of carbon atoms in a honeycomb lattice, has garnered immense interest for its exceptional mechanical strength, electrical conductivity, and thermal transport properties [1, 2]. In this work, we introduce a novel chlorination protocol—using a specialized liquid-phase treatment—to covalently attach chlorine atoms to graphene, and demonstrate dechlorination via targeted proton-beam irradiation to restore the pristine lattice [3].
Raman spectroscopy serves as our primary diagnostic tool: shifts in the D- and G-band positions, changes in the 2D-to-G intensity ratio, and the emergence of defect-related peaks unambiguously reveal the success and extent of both chlorination and subsequent dechlorination. We complement Raman data with FTIR spectroscopy to confirm C–Cl stretching modes, Raman imaging to map spatial heterogeneity in functionalization, zeta-potential measurements to track surface charge evolution, and I–V profiling to correlate chemical state with electronic transport.
This proton-beam dechlorination approach opens exciting avenues for radiation-tolerant graphene devices in space environments, where tunable defect densities can be engineered and tracked entirely via Raman metrics. Overall, our methodology underscores Raman spectroscopy's indispensable role—not only for verifying covalent modifications but also for guiding process optimization and mapping functionalization on the nanoscale—thereby broadening graphene's applicability in advanced technological and space-oriented applications.

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