

Absorption and Luminescence of Chemically and Electrochemically Doped Graphene Nanoribbons

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Graphene nanoribbons (GNRs) are narrow stripes of graphene that exhibit unique optical and electronic properties depending on their width and edge type. Recent advances in the bottom-up synthesis of GNRs have enabled precise control over their structure and thus their bandgap. However, the systematic optical and electrical characterization of GNRs obtained from solution-mediated reactions has so far been prevented by the poor stability and processability of GNR dispersions. Here we employ liquid cascade centrifugation (LCC) to obtain size-selected and stable dispersions of bottom-up synthesized 9-aGNRs in toluene and tetrahydrofuran and investigate their intrinsic optical properties. Dispersions and films of these 9-aGNRs show well-defined absorption and photoluminescence bands between 800 and 1000 nm, with relative intensities depending on the LCC-fraction. The best GNR dispersions show photoluminescence quantum yields of up to 70 %. Trions are charged excitons with red-shifted emission that can be created in doped low-dimensional semiconductors, such as carbon nanotubes [1]. Theoretical studies have predicted large trion binding energies (> 300 meV) in graphene nanoribbons (depending on their width), however, so far they have not been observed experimentally. Chemical doping of 9-aGNRs in dispersion with the molecular p-dopant F4-TCNQ and electrochemical doping of GNR thin films in ambipolar electrolyte-gated field-effect transistors result in the expected bleaching of the main absorption bands but also the emergence of new redshifted and well-defined charge-induced absorption peaks, which may indicate the existence of trions in GNRs.

References

[1] Zorn et al. *ACS Nano* **2020**, *14*, 2412-2423.