Carbon Nitride Thin Film Materials: A new method for deposition of large area thin films of crystalline carbon nitride onto any substrate at room temperature

Satyam Ladva, William Travis, Tim Nunney, Richard White, Robert Palgrave

University College London, 20 Gordon Street, WC1H 0AJ, London, United Kingdom
Satyam.ladva.13@ucl.ac.uk

Two-dimensional carbon nitride materials have gained a significant interest with regards to energy based applications; in particular as alternatives for existing semi-conductor and photo-capacitor applications including potential use in lithium and sodium ion batteries.
Recent advances in carbon nitride synthesis have yielded highly crystalline triazine-graphitic carbon nitride flakes [1-3] and separately RF magnetron sputtered amorphous carbon nitride films [4, 5]. Here we report a new one-step CVD route to crystalline carbon nitride films on a wide range of substrates held at room temperature, including flexible plastics, silicon wafers and conductive glass.
Films were characterized using SEM, XPS, elemental analysis and Raman spectroscopy. From XPS analysis, C/N ratios between 1.7 to 2.0 were found for the different substrates with oxygen percentage ranging from 7% to 11% however, a single level of etching for 60seconds at 1000eV resulted in the C/N ratio dropping to 1.0 with oxygen levels falling to below 1% confirming the high nitrogen content and high purity of the carbon nitride films with oxygen merely a surface contaminant. Evidence of a graphitic structure was confirmed through XRD, where a diffraction peak at 26.6 degrees was observed, corresponding to a layer spacing of 0.335nm; as well as Raman spectroscopy, where a convoluted D and G peak were present on all substrates between 1200cm^{-1} and 1600cm^{-1}.
Electrical properties of the thin films have been confirmed through the application of impedance spectroscopy, giving a resistance value of approximately $10^{10}\Omega$ (in agreement with past studies [4, 5]) and Hall probe measurements with potential optical properties being evident through UV-visible spectroscopy and XPS valence band analysis, indicating a band gap of 2.75(±0.1)eV depending on the substrate type and film thickness but consistent with polymeric carbon nitride films procured in existing literature [6].

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