

ABSTRACT

The synthesis of large-area graphene and nitrogen doped graphene films by atmospheric pressure chemical vapour deposition, for application in electrochemical sensors provides a new platform for developing inexpensive techniques for selective and ultrasensitive detection of electroactive biomolecules. Therefore, optimum growth condition for the synthesis of good quality bilayered graphene films by APCVD technique on a Cu catalyst was developed (10 minutes growth time; 10 sccm of methane). The quality and thickness of the as-synthesized graphene films was further improved by using 3 sccm of hydrogen gas throughout the annealing and growth process. Doping of graphene with nitrogen atoms has been reported to be the most promising technique for modulating the structural and electrochemical properties of as-grown graphene films. A synthesis method for growing nitrogen doped graphene films with high nitrogen content was obtained by in-situ route using 5 sccm of ammonia. Furthermore, both overall nitrogen content (N/C) and configurations in N-doped graphene films were controlled by varying the growth times (i.e. 2, 5, 10, and 20 min). The results indicated that short growth time (2 min) led to N-graphene films that are rich in pyridinic-N and highest N/C value (4.68 %), while longer growth time (20 min) resulted in formation of graphitic-N rich films with N/C value of 2.84 %. Electrocatalytic activity of pristine and N-doped graphene films as well as pristine and N-graphene-platinum and palladium composites were investigated towards oxidation of dopamine and uric acid. Nitrogen doped based and metal-composite based electrochemical sensors showed better electrocatalytic activity and sensitivity compared to their undoped counterparts. Apart from single atom doping graphene with nitrogen atoms, co-doping with boron and nitrogen atoms was investigated for formation of semiconducting hybrid materials with tunable optical properties. By adjusting the flow rates of methane and the vaporization temperature of boric acid, two types of graphene and hexagonal boron nitride (*h*-BN) hybrid films were formed. This included novel crystalline hexagonal boron nitride (*h*-BN) quantum- and nanodots embedded in large-area boron carbon nitride (BCN) films and the atomically thin and quaternary semiconducting hybrid films of boron carbon oxynitride (BCNO).