Direct RF Plasma Modification of Graphitized Carbon Nanoporous Films and GrO 2D Material

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The short review devoted to observation of RF hydrogen/nitrogen plasma effect on thin nanoporous graphitized carbon layers [1] and graphene oxide (GrO) 2D material. At first, active factors affected on the materials located under RF plasma discharge are analyzed. It was shown that combination of applied alternative field, UV and soft x-ray irradiation and protons can be considered as radiation enhanced hydrogen modification of thin semiconductor layers [2]. Due to direct effect of the plasma on the carbon materials the treatments were performed for short time (15-30 sec) and low power (0.5 – 0.7 W/cm^2). For analyzing of the physical and chemical properties of the RF plasma treated layers such methods as XPS, XRD/XRR, Raman scattering spectroscopy, FTIR spectroscopy, AFM, electrical conductivity measurement at direct and alternative currents have been used. It was shown that RF plasma treatment in N_2 and N_2/H_2 results in nitridation of carbon network and additional hydrogen in plasma increases of electrical conductivity of the thin porous graphitic film. Surface of both these films becomes more hydrophilic and significantly increases chemical sensor sensitivity of the resistance to ammonium with decreasing of the sensitivity to water vapor. That is important that thickness of the films do not decrease considerably. Treatment by N_2/H_2 plasma for 15 seconds (with additional heating at 150°C) of thin film of GrO fabricated by drop casting method resulted in enhanced resistance reduction more than one order of magnitude in compare with thermal annealing in vacuum at 200°C for 15 minutes. It's worthy noting that thickness of the GrO film after the plasma treatment decreases by 60% while the thermal annealing for 15 minutes by 40%÷50%. Besides, it was shown by XPS method that the N_2/H_2 plasma treatment led to nitridation of the GrO film, forming of the pyrrole-like and pyridine-like nitrogen groups. It should be noted that the plasma reduced (PR) GrO films by N_2/H_2 plasma is saturated by hydrogen (FTIR results) that is not observed at thermal annealing in ambient atmosphere [3]. Mobility of the carriers (electrons) in PR GrO film is enough small (about 0.1 cm^2/(V sec)) but on 30% higher than after thermal annealing in vacuum at 250°C for 15 minutes.

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References

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