Carbon Nitride Oxide as Precursor of the Azaraphene

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Abstract To synthesize azagraphene [1] in monolayer which the maximum possible number of atoms of carbon replaced by atoms of nitrogen, from carbon nitride (as well as graphene was obtained from graphite) is most interesting and urgent problem of the next step in the development of carbon nanochemistry after the successful synthesis of carbon monatomic molecules and nanostructures. First a new substance – water-soluble carbon nitride oxide (g-C_3N_4)O, which is an analogue of graphite oxide (GO), was synthesized by gas phase method under the special reactionary conditions of the pyrolysis of melamine [1] and urea [2]. For the first time at the reduction of carbon nitride oxide (g-C_3N_4)O by hydroquinone, the reduced carbon nitride (or reduced multi-layer azagraphene) is obtained [3]. According to the results of chemical analysis and IR spectrometry (Fig. 1c) the chemical bonds between atoms in a heteroatomic plane of reduced carbon nitride (RCN) correspond to the bonds in a synthesized carbon nitride (SCN). In Figure 1b shows schematic atomic model of one layer of synthesized carbon nitride (SCN) (the in-plane distance between the heptazine fragments (C_6N_7) d = 0.714 nm). In one layer of carbon nitride oxide (CNO) the in-plane distance increases to d = 0.818. The increase (on 0.104 nm) this in-plane distance in a monolayer of (g-C_3N_4)O can be connected to the break of some of C–N bonds between the heptazine fragments and tertiary atom of nitrogen ((C_6N_7)–N–(C_6N_7)) in the openwork plane. After reduction (and consequently removing oxygen-containing groups) in-plane distance in a heptazine monolayer of the reduced carbon nitride (RCN) again decreases to d = 0.714 (it becomes the same as that of the SCN). However, RCN has a significantly greater (on 0.09 nm) interplanar distance between the adjacent nitrogen-carbon layers than interplanar distance between the layers of SCN as shown of the results of X-ray diffraction analysis (Fig. 1a). Reduced carbon nitride as well as a reduced (from graphene oxide) graphene consists of poorly connected heteroatomic azagraphene and monoatomic graphene layers respectively. On the basis of comparison of the characteristics of bulk C_3N_4 and improved characteristics of carbon nitride nanosheets, we believe, that the in contrast to bulk g-C_3N_4 the reduced carbon nitride will have more superior electrophysical characteristics and photocatalytic activity.

References

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Figures

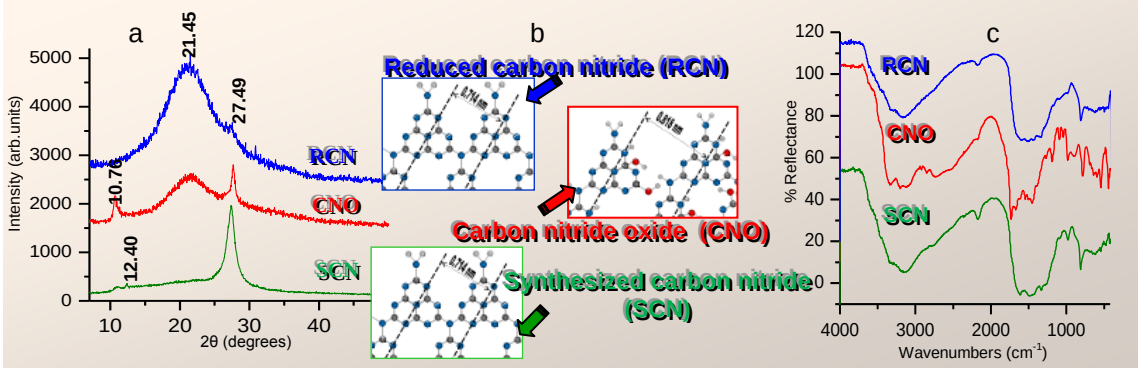

Figure 1. XRD patterns (a), IR spectra (c) and schematic atomic models of one layer (b) of reduced carbon nitride (RCN), carbon nitride oxide (CNO) and synthesized carbon nitride (SCN).