The influence of nitrogen doping on the adsorption of organic solvent vapors by carbon nanotubes and few-layer graphene nanoflakes

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Carbon nanomaterials are widely used for adsorption of organic pollutants [1]. They have high specific surface area and adsorption capacity. Variation of synthesis conditions allow to control the pore size distribution. The presence of certain functional groups on surface can stimulate the adsorption of certain solvents vapors.

This work focuses on the influence of nitrogen doping on adsorption characteristics of carbon nanotubes (CNT) and few-layer graphene nanoflakes (GNF). Carbon nanomaterials were obtained by pyrolitic decomposition of hexane (for pristine materials) / acetonitrile (for N-doped materials) on a mesoporous oxide catalyst.

Vapor sorption of acetone, ethyl acetate, toluene and acetic acid on doped and pristine materials was investigated. Using the BET method, specific surface area S values were determined. They are in agreement with data of low temperature nitrogen adsorption. Few-layer graphene nanoflakes demonstrate the highest value of S (1400 m^2/g). Next is N-doped analogue (400 m^2/g), then N-CNT (260 m^2/g) and finally CNT (160 m^2/g).

Using measurements at two temperatures (20 and 30 °C), values of isosteric heat of sorption Q_{st} were obtained. It was found that few-layer graphene nanoflakes are more preferable for adsorption of polar solvents, because heat of sorption for selected adsorbates increases with an increase in their dipole moment from 35 to 39 kJ/mol. N-doped materials proved to be best sorbents for acetic acid due to the basic properties of functional groups and chemical bonding between molecules of adsorbate and adsorbent. The highest values of heat of adsorption were obtained for N-CNT (Q_{st} = 41 kJ/mol) and N-GNF (Q_{st} = 49 kJ/mol).

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References

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