Nanodiamond Surface Functionalization under Thermal Treatment in CCl_4: Thermodesorption Mass Spectrometry Study

Gorokhov P.V. [1], Koscheev A.P.[1], Karzhenevsky A.P.[2], Olesik F.N.[2], Spitsyn B.V.[3]

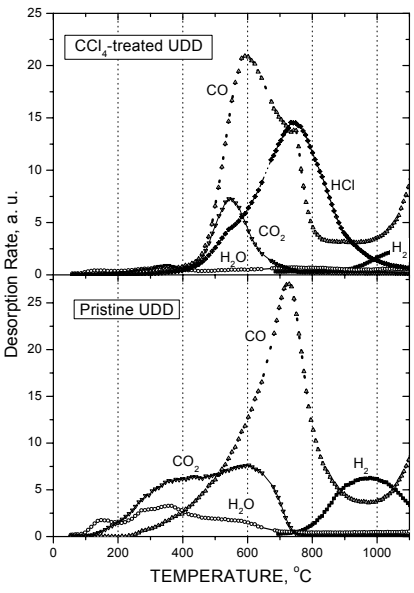
[1]*Karpov Institute of Physical Chemistry, 105064 Moscow, Russia*
[2]*Joint-Stock Co " SINTA", 220062 Minsk, Belarus*
[3]*Institute of Physical Chemistry and Electrochemistry RAS, 119991 Moscow, Russia*

Introduction. The behavior of ultradisperse detonation nanodiamond (UDD) in various environments is controlled by their surface properties which in turn depend on the details of detonation synthesis and chemical purification procedure [1]. As a rule the surface of commercially available UDD contains a number of functional groups of different composition and structure. The problem exists to unify and/or to modify the surface chemistry of UDD in an appropriate manner. One of the ways in this direction is the high-temperature treatment of UDD in CCl_4 [2]. We present the results of thermodesorption mass spectrometry (TDMS) study of UDD surface chemistry after this type of modification.

Experimental. UDD powder type UDA-SP produced and purified by "Sinta" was used as pristine material. Final chemical treatment was performed in the flow of CCl_4/Ar mixture at 400ºC for 1 and 5 hours. TDMS spectra were measured by quadrupole mass spectrometer under programmed heating (10ºC/min) the sample up to 1100ºC in vacuum.

Results and discussion. The main products of thermodesorption from pristine UDD were CO (400-800ºC), CO_2 (200-700ºC), H_2O (100-600ºC) and H_2 (800-1100ºC) (see Figure). The complex shapes of thermodesorption profiles (especially in the case of CO_2 and H_2O) indicate the presence of a number of surface H- and O-containing species of various configurations.

A substantial amount of HCl was found to release from modified sample (main peak at 740ºC and a shoulder near 550ºC). The HCl concentration increased with treatment duration and was comparable with the released amount of CO and CO_2. At the same time CCl_4-treatment caused the decrease in H_2O (till the background level) and H_2 (tenfold decrease) abundance. The total content of CO_x-yielded surface species was not changed too much though their configuration was modified noticeably as demonstrated by the temperature profiles of CO and CO_2 desorption. In summary, the thermal treatment of UDD in CCl_4 causes, besides drastic uptake of Cl-species, a substantial dehydrogenation (in the form of HCl) temperature lowering and some changes in the state of surface oxidation.



[1] D. Mitev et al. ***Diam. Relat. Mater.*** **16,** 776 (2007).
[2] B.V. Spitsyn et al. *Diam. Relat. Mater.* **15**, 296 (2006).