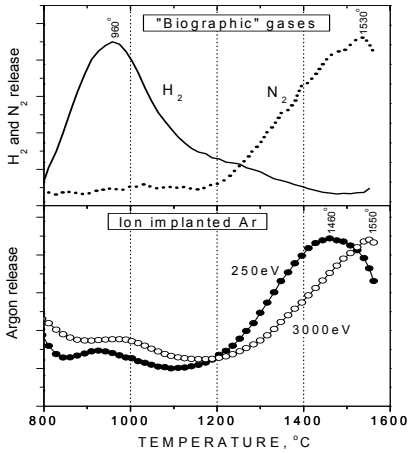
# Nitrogen Release during High Temperature Annealing of Detonation Nanodiamonds in Vacuum

Koscheev A.P.[1], Gorokhov P.V.[1], Gromov M.D. [1], Daulton T.L.[2]

[1]*Karpov Institute of Physical Chemistry, 105064 Moscow, Russia*
*Washington University in St. Louis, St. Louis, MO., 63130, USA*

The graphitization of ultradispersed detonation diamonds (UDD) was observed at temperatures 1100-1600ºC [1]. Some fractions of noble gases implanted into UDD were found to release in the same temperature range [2]. We have studied the structure of high temperature profiles of active gases and implanted Ar released from UDD both under linear heating (7ºC/min) and under isothermal annealing. The structure of UDD particles annealed at different temperatures was characterized by HRTEM.

The most of gases ($H_2O$, $CO_x$, $C_xH_y$) desorbed from UDD below 800ºC. Hydrogen release was observed up to 1200ºC (see Figure). Nitrogen and implanted argon released above 1200ºC. The temperature position of nitrogen release profiles was near the same for the UDD samples of different types (detonation in various environments) though the amount of released nitrogen varied by a factor of two. The release profile of argon shifted to higher temperatures with energy (penetration depth) of implanted ions. We suggest that the desorption of impurity nitrogen and implanted argon is caused by structure transformation of UDD under annealing.




HRTEM studies showed the transformation of the used UDD to graphite onions at temperatures 1200-1500ºC.

The activation energy derived from isothermal measurements of nitrogen release was in good agreement with the published data on the UDD graphitization kinetics [1].

Using these data and assuming the uniform distribution of nitrogen in the bulk of UDD particles one can estimate: 1) the depth profiles of other trace impurities (e.g. noble gases) trapped inside nanodiamond crystals, and 2) the weight fraction of graphitized diamond at any stage of thermal annealing.

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[1] Yu.V. Butenko et al. *J. Appl. Phys*. **88**, 4380 (2000).
[2] A.P. Koscheev et al. *Meteor. Planet. Sci.* **40**, A87 (2005).