GRAPHITIZATION KINETIC OF NANODIAMOND: IMPLICATION FOR CONDITIONS OF NEBULAR PROCESSES OF PRESOLAR GRAINS. C. Le Guillou[1], J. N. Rouzaud[1], N. Findling[1], [1]Laboratoire de géologie de l'ENS, ENS-CNRS UMR 8538, 24 rue Lhomond, 75005 Paris, France. cleguill@clipper.ens.fr

Introduction: Nanodiamonds are known to be present in all class of primitive chondrites [1]. Since then, a correlation between diamond abundances and carbonaceous chondrites groups as well as with petrologic type has been described [2, 3] and interpreted as the results of their progressive destruction during nebular and parent body thermal events. However, the mechanism involved and its corresponding temperature and timescales remains unknown. The volatilization kinetics of silicon carbide in nebular conditions has been described by [4] and led to multiple time-temperature couples for which an incomplete volatilization would occur. Assuming that presolar diamond and SiC are both submitted to the same events, we show that the comparison of their kinetic behaviour can help to restrain the time-temperature range of this specific thermal event.

Experimental: In this study, we performed pyrolysés under argon flow of synthetic nanodiamonds in the temperature range 600°C-1500°C, in order to determine the activation energy of their graphitization rate, which ultimately leads to onion-like carbon nanostructures [5].

Results and Discussion: The reaction occurs between 1000°C and 1500°C. Quantification of the transformed mass fraction of the powder is possible thanks to X-ray diffraction calibration.

The Full Width at Half Maximum (FWHM) of the nanodiamond 111 diffraction line gives information on the crystallite size for different transformation degrees. We do not observe any evolution of the diamond crystallites size, even when more that 80% of the powder has been transformed. This indicates that diamonds react by nucleation of individual grains and not by simultaneous and progressive growth of graphene layers around each diamond particle. Assuming this mechanism, we determine an activation energy of 144 (_ 12) kJ.mol^{-1} and a pre-exponential constant of 4, 89 s^{-1}.

The coupling of this kinetics parameter with those determined for SiC volatilization (figure) is instructive. It shows that time-temperature conditions able to destruct simultaneously nanodiamonds and silicon carbides are in the high temperature range (~ 1300°C) and correspond to short timescales (few minutes to hours). These conditions are intriguingly close to the chondrules formation event conditions.

The graphitization may also explain the presence of onion-like carbons observed in some chondrites [6] by TEM.

Conclusion: the two reactions involved here are kinetically limited and the comparison of their experimental studies enables to determine the time-temperature conditions relevant for a simultaneous reaction.

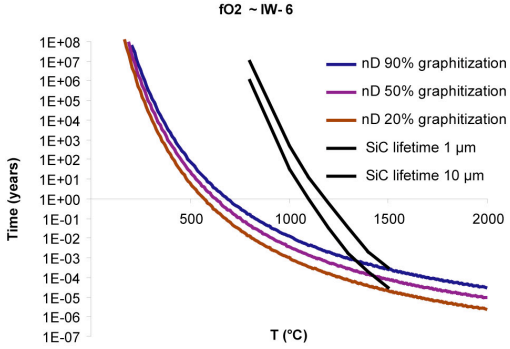

Figure: Time-temperature couples for various transformation degrees of nanodiamond powder and for SiC lifetimes of different grain size.

References: [1] Lewis et al. (1987) *Nature* 326 160-162. [2] Huss R. G.et al. (1995) *GCA* 59 (1), 115-160. [3] Huss R. G. et al. (2003) *GCA*, 67 (24) 4823. [4] Mendybaev et al. *(*2002) *GCA,* 66(4) 661-682. [5] Butenko et al. (2000) *J of App Phys* 88, 4380-4388. [6] [11] Harris P. J. F., Vis R. D., Heymann D. (2000) *EPSL,* 183, p 355.