**Nucleation and growth of graphene**

C.A. Varone* and G.C.A.M. Janssen

Precision and Microsystems Engineering, Delft University of Technology, Mekelweg 2, Delft, The Netherlands
*e-mail: C.A.Varone@tudelft.nl

## Abstract

Graphene is grown from a methane hydrogen mixture on a copper substrate at a temperature around 1000°C by many researchers.
Various qualities have been achieved based on the variation in the process conditions.
In the present work we investigated the influence of the total pressure on the nucleation density where the results are shown in Fig.1. We offer a tentative explanation for the observed pressure dependence. Lower pressure will lead to lower adsorbed fractions of hydrogen and methane fragments.
These in turn will lead to lower fractions of isolated carbon atoms or carbon clusters, whichever is responsible for graphene growth. The nucleation density of graphene will depend on the chance of these atoms or clusters to connect, hence on a power of their density. This chain of events qualitatively explains the steep dependence of nucleation density on pressure.
Our work sheds light on the nucleation process as well determines the window for a low nucleation density, needed for millimeter size single crystals.
In a second series we varied the hydrogen to methane ratio, which has a distinct influence on the shape of the crystals. This dependence is explained by a gradual transition from diffusion limited aggregate growth to quasi-equilibrium growth as the hydrogen to methane ratio is increased as displayed in Fig.2.

## Figures

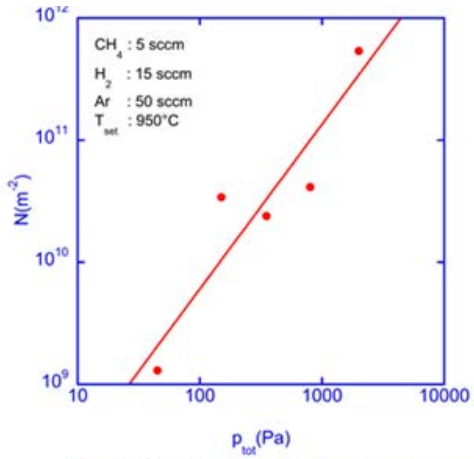


Fig .1 : Nucleation density vs pressure

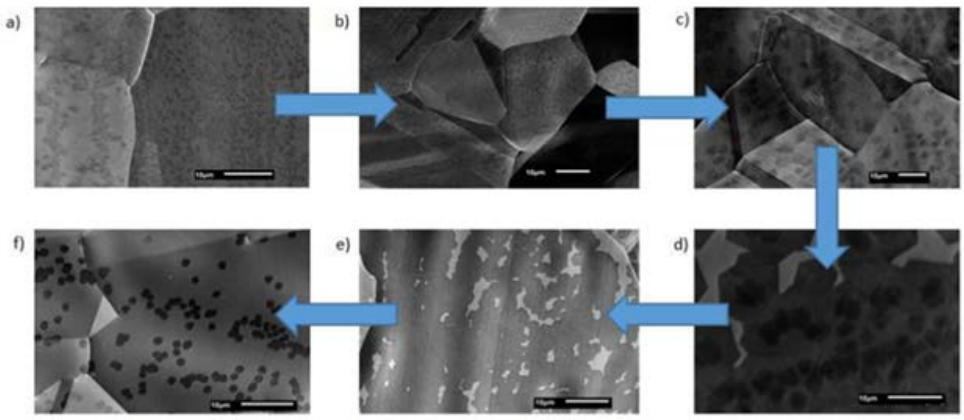


Fig.2:Temperature was kept at 1000 C, hydrogen flow at 1000 sccm, p at 20 mbar.
The flow of methane was decreased from 4 to 0.012 sccm in the direction of the arrows.