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Understanding Gas to Solid Reactions by means of Controlled Atmosphere TEM

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A deep understanding of the formation mechanisms of low-dimensional nanostructures from bottom-up processes is of great importance in order to exploit the controllability of the nanostructures and their applications in photovoltaics, electronics, sensors, *etc.* on an industrial scale.

In order to study the gas to solid reaction mechanisms of the low-dimensional nanostructures, *in situ* growth of tungsten dots (0-D) [1], copper oxide nanowires (1-D) [2] single-wall carbon nanotubes (SWCNT, 1-D) [3] and graphene (2-D) [4] by means of controlled atmosphere TEM has been performed at DTU over the past years. The high spatial resolution combined with spectroscopic capabilities allow for fundamental insights during the dynamical growth processes.

Here, the electron beam driven growth processes of 0-D deposits and temperature driven growth processes of 1-D and 2-D structures will be discussed based on *in situ* electron microscopy studies.

Figure 1 shows an example of transition from a gaseous carbon to solid carbon. The elongation process of a SWCNT is shown by a series of images extracted from a movie, acquired during exposure of a Co/MgO sample to a mixture of CO and H₂ at elevated temperature.

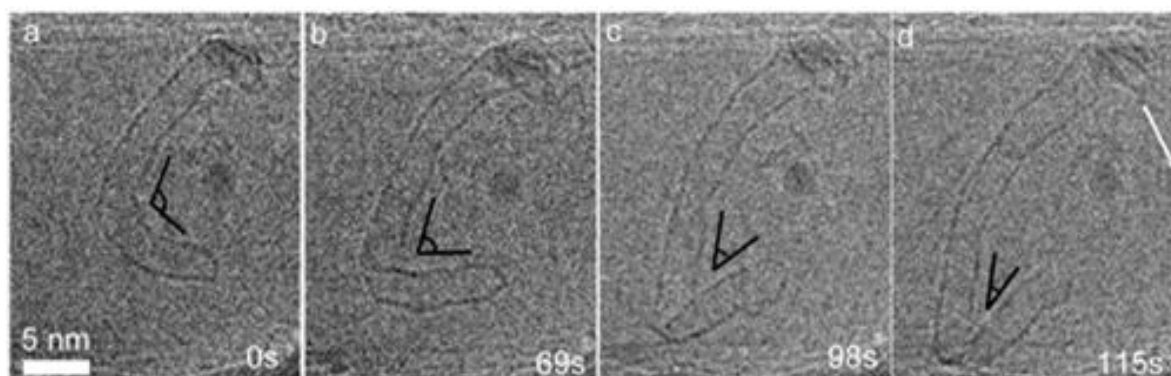


Figure 1: Co/MgO sample exposed to a mixture of CO and H₂ precursor gas (5:2 in mole ratio, totally 760 Pa) at 700°C resulting in the formation of a SWCNT [5].

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