**Dynamic Restructuring Of Solid Catalyst Cluster During Carbon Nanotube CVD**

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It is commonly assumed that the catalyst metal forms a liquid intermediate and that bulk catalyst effects dominate CNT growth dynamics. Calculations of size-corrected melting points and carbon saturation often indicate minimum CNT synthesis temperatures >500°C, seemingly incompatible with the 400-450°C ceiling temperature of present back-end CMOS technology. We present a detailed in-situ and ex-situ analysis of catalyst reconstruction and sintering upon temperature elevation and in particular show how different atmospheres influence the de-wetting and activation of solid transition metal films on Si/SiO2. In-situ environmental HRTEM shows that Ni films supported on SiOx membranes already start restructuring at temperatures as low as 200°C and that the bulk of the catalyst cluster is crystalline but highly mobile during CNF and SWNT CVD. The constant catalyst cluster reshaping is driven by catalytic carbon deposition and the occurring surface energy minimization. The tubular CNF shape anisotropy results from an elongation/contraction scenario of the catalyst cluster in the tip. For SWNTs, we observe mainly root growth with a carbon layer lifting off a reshaped, crystalline catalyst. We report single wall CNT CVD at temperatures below 450°C from undiluted C2H2 and demonstrate field effects in as-integrated CNT FETs [1]. We suggest that surface[2], rather than bulk catalyst effects, dominate CNT growth kinetics for low temperature, surface-bound CVD and analyse the potential narrowing of the chirality distribution.

1. Cantoro et al., Nano Lett. 6, 1107 (2006) 2. Hofmann et al., Phys. Rev. Lett. 95, 036101 (2005)