Swinging Crystal Edges of Growing Carbon Nanotubes

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Recent measurements of the growth kinetics of individual carbon nanotubes revealed abrupt changes in the growth rate of nanotubes maintaining the same crystal structure [1]. A simple model, derived from our previous analysis of the role of the configurational entropy of the nanotube edge [2] and supported by Kinetic Monte Carlo [3] and Molecular Dynamics simulations [4], shows that these switches are caused by tilts of the growing nanotube edge between two main orientations, close-armchair or close-zigzag, inducing different growth mechanisms. Beyond providing new insights on nanotube growth, these results point to ways to control the dynamics of nanotube edges, a key requirement for producing arrays of long structurally-selected nanotubes. More generally, the thermodynamics and kinetics of carbon nanotube growth are discussed.

References

[1] Pimonov V. *et al*. (2021). Dynamic Instability of Individual Carbon Nanotube Growth Revealed by In Situ Homodyne Polarization Microscopy. *Nano Letters*, *21*(19), 8495–8502. https://doi.org/10.1021/acs.nanolett.1c03431
[2] Magnin Y., *et al.* (2018). Entropy-driven stability of chiral single-walled carbon nanotubes. *Science*, *362*(6411), 212–215. https://doi.org/10.1126/science.aat6228
[3] Förster G. D., *et al.* (2023). Swinging Crystal Edge of Growing Carbon Nanotubes. *ACS Nano*, *17*(8), 7135–7144. https://doi.org/10.1021/acsnano.2c07388
[4] Hedman D., et al., https://doi.org/10.48550/arXiv.2302.12077

Figures

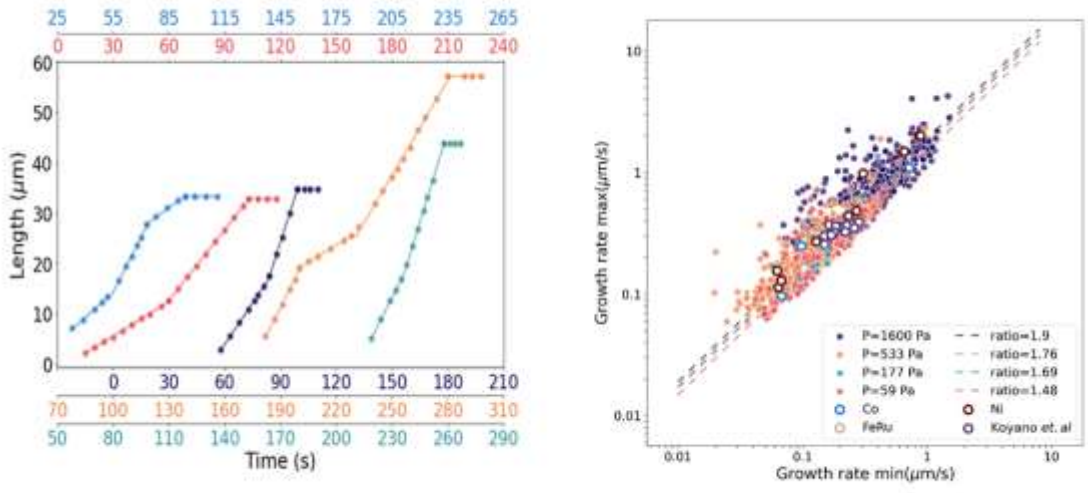

Figure 1 Left: Experimental growth rates showing sharp changes for tubes maintaining the same chirality. Right: Strikingly, the ratio of fast over slow growth rates is almost constant, around 1.7, for all pressure (and temperature) conditions and catalysts [1, 3].