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Role of plasma activation in the kinetics of CNT growth in PECVD process IRINA LEBEDEVA, Kintech Lab Ltd, ALEXEY GAVRIKOV, ALEXEY BARANOV, MAXIM BELOV, ANDREY KNIZHNIK, BORIS POTAPKIN, Kintech Lab Ltd, TIMOTHY SOMMERER, GE Global Research Center —
The work presents kinetic modeling of the effect of acceleration for the growth kinetics of carbon nanotubes by hydrocarbon gas mixture modification with plasma discharge. The plasma activation creates active species in hydrocarbon gas mixture, which can easily adsorb and dissociate on the catalyst surface. So plasma treatment of the gas mixture in the CVD process allows to increase the carbon supply rate by a few orders of magnitude compared to that in thermal CVD process. On the other hand, plasma can also provide etching of carbon species from the catalyst surface. To correctly reproduce both of these effects of plasma, the kinetic model of growth of carbon nanotubes is developed based on first-principles analysis of heterogeneous processes on the catalyst surface and detailed kinetics of gas phase chemistry. The model is used to compare the growth rates of carbon nanotubes in thermal and plasma-enhanced CVD processes and to determine critical gas pressures, at which CNT growth kinetics switches from the adsorption limitation to the limitation by reaction and diffusion on the catalyst.

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