Exploiting the Limitation of Fischer-Tropsch Synthesis for Efficient Production of Carbon Nanotubes

Placidus Amama, Ph.D.
Associate Professor & Tim Taylor Chair in Chemical Engineering
Tim Taylor Department of Chemical Engineering
Kansas State University, Manhattan, KS 66506

There has been growing interest in scalable growth of carbon nanotubes (CNTs) because of their suitability in a growing number of important large-scale applications such as composites, energy storage, and catalysis. Although significant progress has been made in the past two decades in scaling up CNT production via catalytic chemical vapor deposition (CVD), the process still faces key challenges such as short catalyst lifetime, low catalyst nucleation density, slow production rate, variations in CNT properties, and high cost of CNTs. To address these challenges, research activities have focused primarily on rational catalyst design and control of the nucleation and growth processes at the catalyst site, while less attention has been paid to innovating the feedstock. In my talk, I will discuss the use of the waste stream of Fischer-Tropsch synthesis (FTS) process (FTS-GP) as a feedstock for scalable and controlled growth of CNTs. Unlike conventional feedstocks (C_2H_2, C_2H_4, C_2H_5OH, etc.) that require strict process control, growth properties of CNTs (growth rate, area density, and quality) are generally less sensitive to FTS-GP fraction in the feed, and thus allow for easy optimization and scale-up. In addition, I will discuss our efforts to develop a closed-loop material cycle whereby CNTs grown by FTS-GP CVD are utilized as catalyst supports in FTS process. A comparison of FTS-GP CVD with other conventional CVD processes reveals growth performance (in terms of catalyst lifetime and growth rate) that is superior. FTS-GP CVD provides a new pathway for scalable, low-cost, and continuous production of CNTs while simultaneously reducing emissions of flue gases.