

Graphene Innovations Drive Nano Material Manufacturing Technologies

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Abstract:

Many different processing methods have been demonstrated over the last 20 year for 1D and 2D nanomaterial manufacturing. Worldwide interest over the last 10 years has been focused on advancing the state of the art and quality of CVD graphene manufacturing. A wide range of CVD manufacturing methods and equipment solutions have been explored and their respective benefits and drawback analyzed in relation to the quality and scalability of CVD graphene material.

Worldwide focus in manufacturing processes for high performance wavelength-division multiplexing (WDM) filter technology in 1995-2005 advanced the optical thin film coating industry by developing real time inline optical monitoring systems. Similarly, CVD graphene manufacturing processes are the driving force behind recent innovations in CVD equipment. The knowledge gained in solving CVD graphene equipment and processes are often adaptable to advancing the manufacturing and commercialization of other nano materials.

We will report here how our CVD graphene research, processing and equipment innovations have inspired a similar advancement in nano material manufacturing scale-ups in VACNT's and SiNW's.

We will also show, by example how challenges in utilizing Ethanol as a liquid precursor to create a more reproducible bilayer of CVD graphene inspired us to enhance our CVDWinPrC™ control software to provide real time diagnostic feedback control for all types and sizes of liquid Bubblers. To do this we developed an online Bubbler fill level software/hardware solution that determines the Bubbler fill level accuracy to better than 0.5% and also measures the Bubbler vapor pickup efficiency to better than 5%. This and other CVD system tests are now automated and can be run after hours or between production runs as desired to make sure the liquid precursor delivery is reproducible. It also enables process recipes based on measured Bubbler efficiencies and can help all CVD processes that utilize a Bubbler as a precursor source.