Large Scale Nanofermentation of Quantum Dots

Nanofermentation is a novel approach to the synthesis of nanomaterials. The basic process uses bacteria to facilitate the controlled growth of nanomaterials. The specific organisms under investigation, thermophilic anaerobic bacteria, excrete copious amounts of materials external to their cell. Oak Ridge National Laboratory (ORNL) recently demonstrated that, through the addition of chemical control agents, it is possible to control the particles size (from 3 nm to 300 nm) and shape. Recent experiments have demonstrated that these bacteria can likewise synthesize a variety of candidate materials for quantum dots.

The specific advantage of nanofermentation, as demonstrated on a recent Defense Advanced Research Project Agency (DARPA) program, is scalability. The specific yield of materials is approximately 3 grams of material per liter of solution per month. A recent investigation demonstrated that this process efficiently scaled from mg to kg samples. The potential for large scale nanomanufacturing could truly be a disruptive technology. As an example, a single 50,000 gallon fermentor could provide yields approaching 500 kg/month. In terms of photovoltaics, this could correspond to 0.9 MW of PV materials. The basic process is energy efficient, only requiring the heating of the fermentor.

This nanomanufacturing concept definition study will first analyze bacterial synthesized materials to quantify their potential for photovoltaic (PV) and solid state lighting (SSL) materials. ORNL will perform scaling analysis to estimate bulk material production rates and costs. Finally, ORNL will perform a market analysis to estimate the impact nanofermentation could have on future PV and SSL materials, and identify critical R&D paths and industrial partners for commercialization and transition of the technology to concept development.

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