Washington University in St. Louis
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SCALABLE SYNTHESIS OF STABLE, HIGHLY CONDUCTIVE, SOLUTION-PROCESSABLE PEDOT PARTICLES FOR ORGANIC ELECTRONICS

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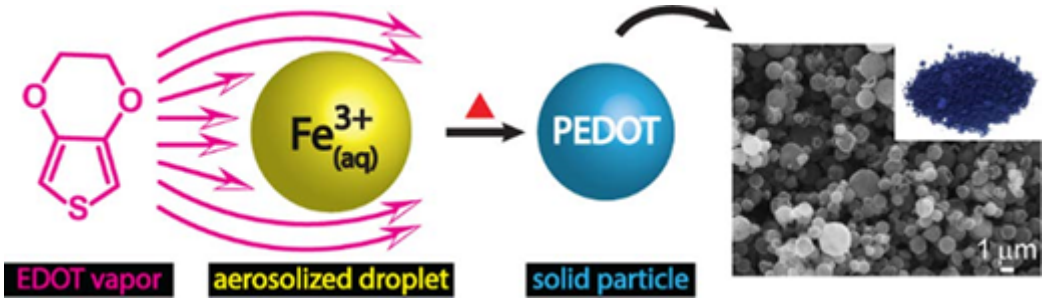
Technology Description

Researchers in Prof. Julio D'arcy's laboratory have developed aerosol vapor polymerization (AVP), a scalable continuous batch-processing platform to produce bulk quantities of stable submicron conductive particles for organic electronics. Unlike traditional PEDOT:PSS (poly(3,4-ethylenedioxythiophene) with polystyrene sulfonate), resulting "AVP-PEDOT" particles are readily processed in both organics and water.

Current strategies to synthesize conducting polymers for organic electronics result in materials that are unstable and difficult to process. In particular, PEDOT:PSS (the most common conducting polymer formulation) is synthesized using an energy-intensive multistep process using a dopant (PSS) that separates in nonaqueous solutions and limits conductivity. AVP solves these problems using a hybrid scalable approach with an aerosol and monomer vapor flow reaction. This bulk synthesis produces submicron-sized conducting polymer particles ("AVP-PEDOT") with the highest conductivity reported to date. In addition, the particles remain doped for months and can be readily processed in water and organic solvents for end user applications in sensors, energy harvesting/storage and flexible electronics.

Schematic overview of AVP-PEDOT synthesis



Stage of Research

- **Proof of Concept** – The inventors used aerosol vapor polymerization (AVP) to produce bulk quantities of discrete solid-state submicron particles (750 nm diameter) with the highest reported particle conductivity (330 ± 70 S/cm) to date. They demonstrated that those particles are dispersible in organics and water and remain electrically conductive and doped over a period of months.
- **Publication -** Lu, Y., Kacica, C., Bansal, S., Santino, L. M., Acharya, S., Hu, J., ... & Yang, H. (2019). Synthesis of Submicron PEDOT Particles of High Electrical Conductivity via Continuous Aerosol

Vapor Polymerization. *ACS applied materials & interfaces*, 11(50), 47320-47329.

Applications

- **Organic electronics** – readily-processed PEDOT particles for developing aqueous charge-stabilized colloids or semiconducting composites with end user applications such as:
  - flexible electronics
  - energy harvesting and storage
  - pH and temperature sensors

Advantages

- **Solution-processable in organics and water:**
  - soluble particles readily disperse in water
  - unlike conventional PEDOT:PSS, AVP-PEDOT particles do not need surfactants for developing thermoplastic and cementitious solid-state composites
- **Stable particles with high conductivity:**
  - highest reported particle conductivity (330 ± 70 S/cm)
  - discreet particles remain doped for months
- **Bulk synthesis of tunable particles:**
  - scalable continuous batch-processing technique
  - spherical, submicron-sized PEDOT particles can be produced continuously and in large quantity (100 mg/hour)
  - size distribution and electrical conductivity are tunable

Patents – Application pending

Additional Publication - A drugstore solution for synthesizing stable semiconducting polymers, *The Record*, Feb. 7, 2020

Related Web Links – D'arcy Lab