

# **Organic-Soluble Intrinsically Conducting Polymers Based On Poly(3,4-ethylenedioxythiophene)**

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**Shawn Sapp, Silvia Luebben, and Emily Chang**

# TDA Research, Inc.

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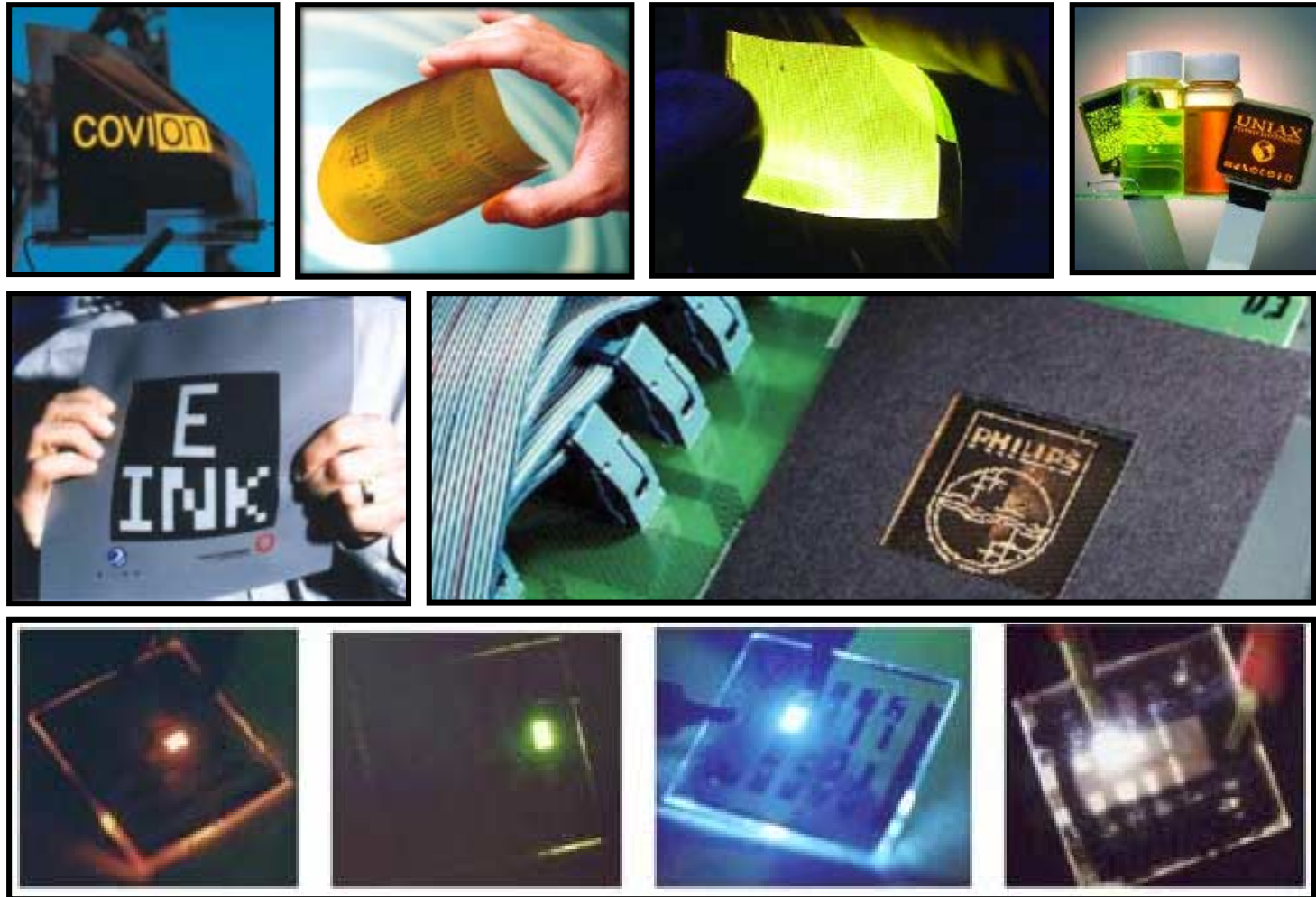
## Facts & Figures

- Privately Owned
- Began operations in 1987
- 62 Full-time technical staff (60% with advanced degrees)
- 10 Million annual revenue
- 20,000 ft<sup>2</sup> Facility (adding 27,000 ft<sup>2</sup> chemistry facility Fall 2003)

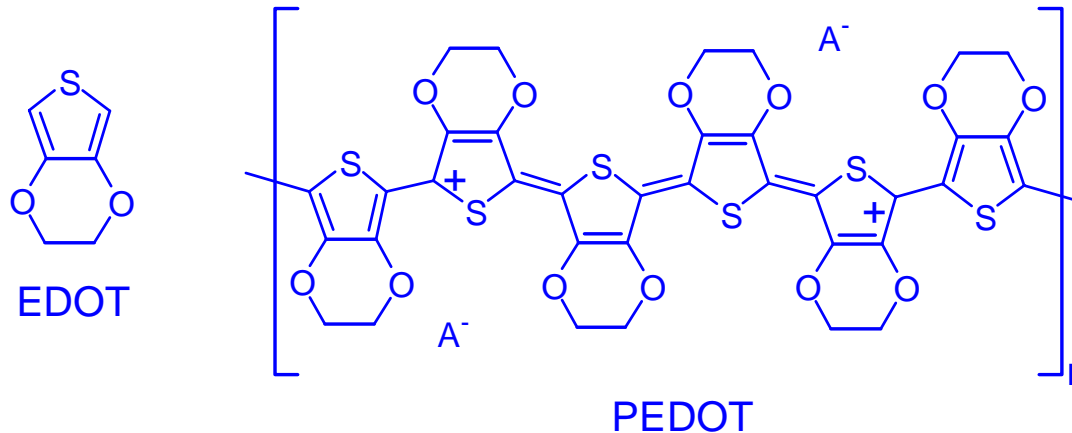
## Expertise

- Polymers
- Nanoparticles
- Catalysis
- Fullerenes and Carbons
- Gas Absorption / Adsorption
- Ceramics
- Aerospace

# Organic Soluble Conductors – Motivation



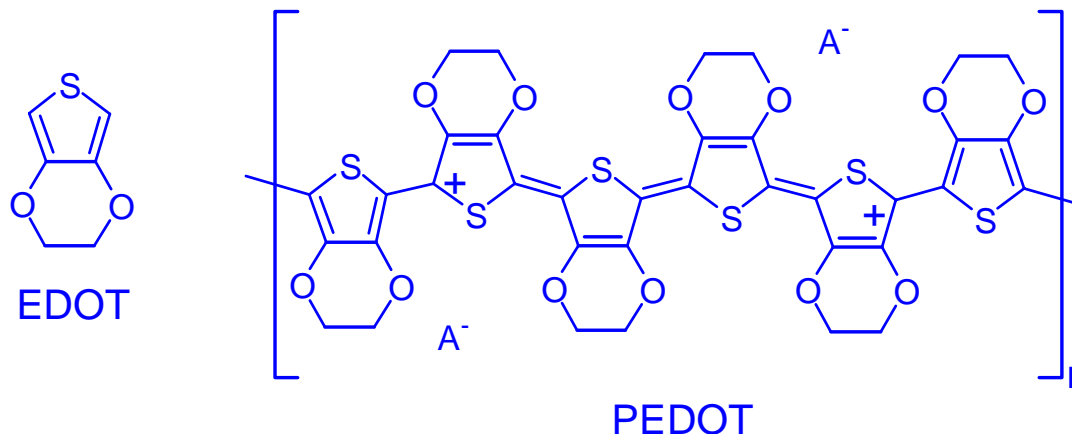
# PEDOT – Success Story



- First truly commercially successful intrinsically conducting polymer (ICP)
- Produced in several forms by Bayer AG as the Baytron<sup>®</sup> product line
- Conductivity up to 10<sup>2</sup> S/cm for pure PEDOT
- Good stability in air and at elevated temperatures
- Highly transparent as a thin-film
- Commercially successful as an antistatic layer in photographic films
- Widely used as a hole injection layer in prototype OLED displays

# PEDOT – Limitations

- By itself, it is insoluble and infusible  $\Rightarrow$  **non processable**
- Dispersible in water with use of poly(styrene sulfonic acid) as dopant (Baytron<sup>®</sup>P)
- Baytron<sup>®</sup>P films have lower conductivity than bulk PEDOT
- Baytron<sup>®</sup>P does not wet glass and plastic substrates without binders. Binders decrease the conductivity of films.
- Water is not an acceptable solvent in many electronic and coating applications
- Films of Baytron P have poor scratch resistance



# TDA's Polymers

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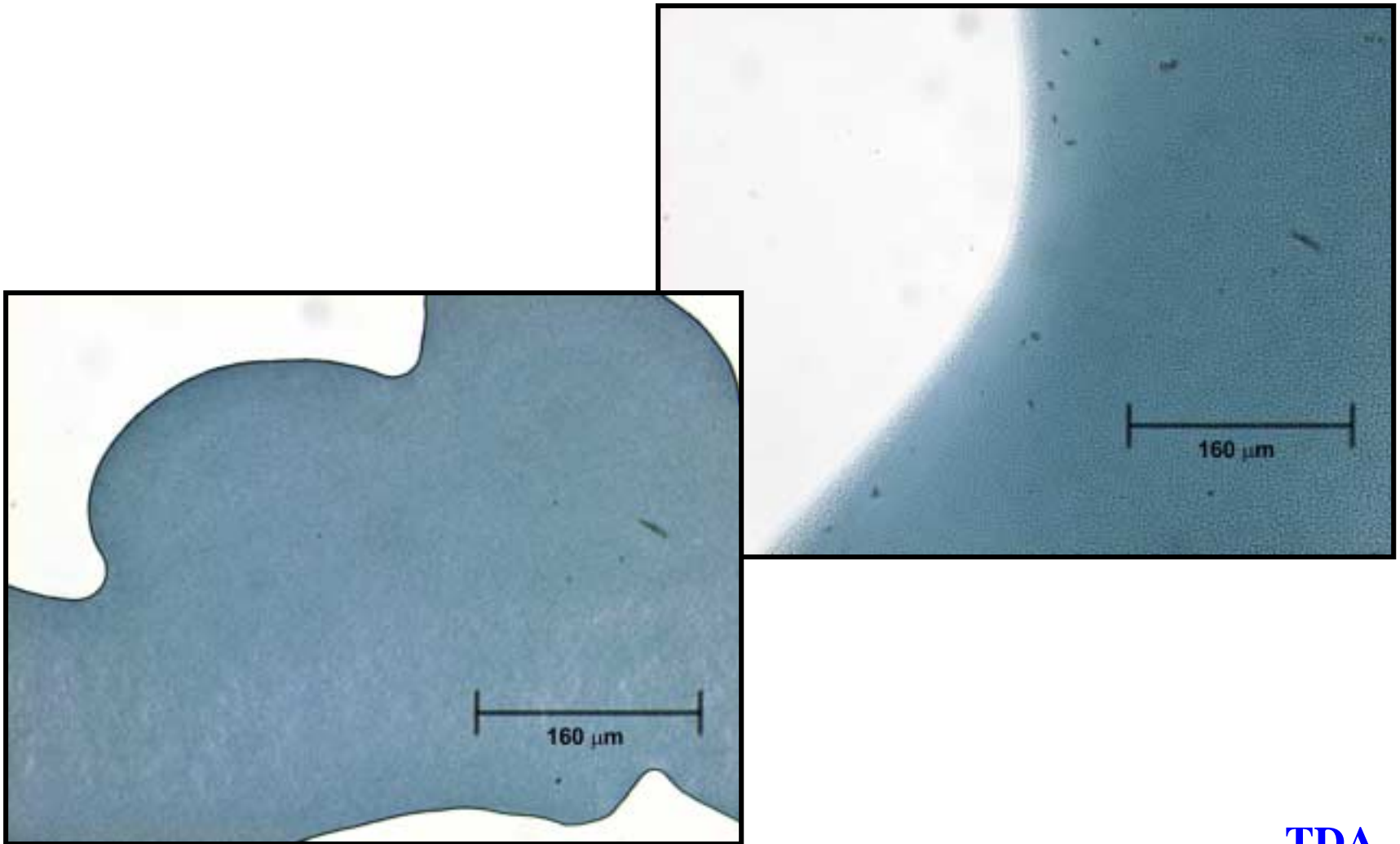
- TDA is developing new PEDOT-based ICPs that are soluble or dispersible in organic solvents at 1 – 8 wt. %
- TDA's ICPs are stable in solution for months
- TDA's ICP solutions wet and bind organic and inorganic substrates with no need for binders
- TDA's ICP solutions can be applied as paints, adhesives, or thin films
- We are currently investigating the possibility of blending our ICPs with other polymers or resins
- We are also in the process of studying the effects of cross-linking to improve scratch resistance and mechanical properties of our ICPs

# TDA's Polymers – Gels and Solutions

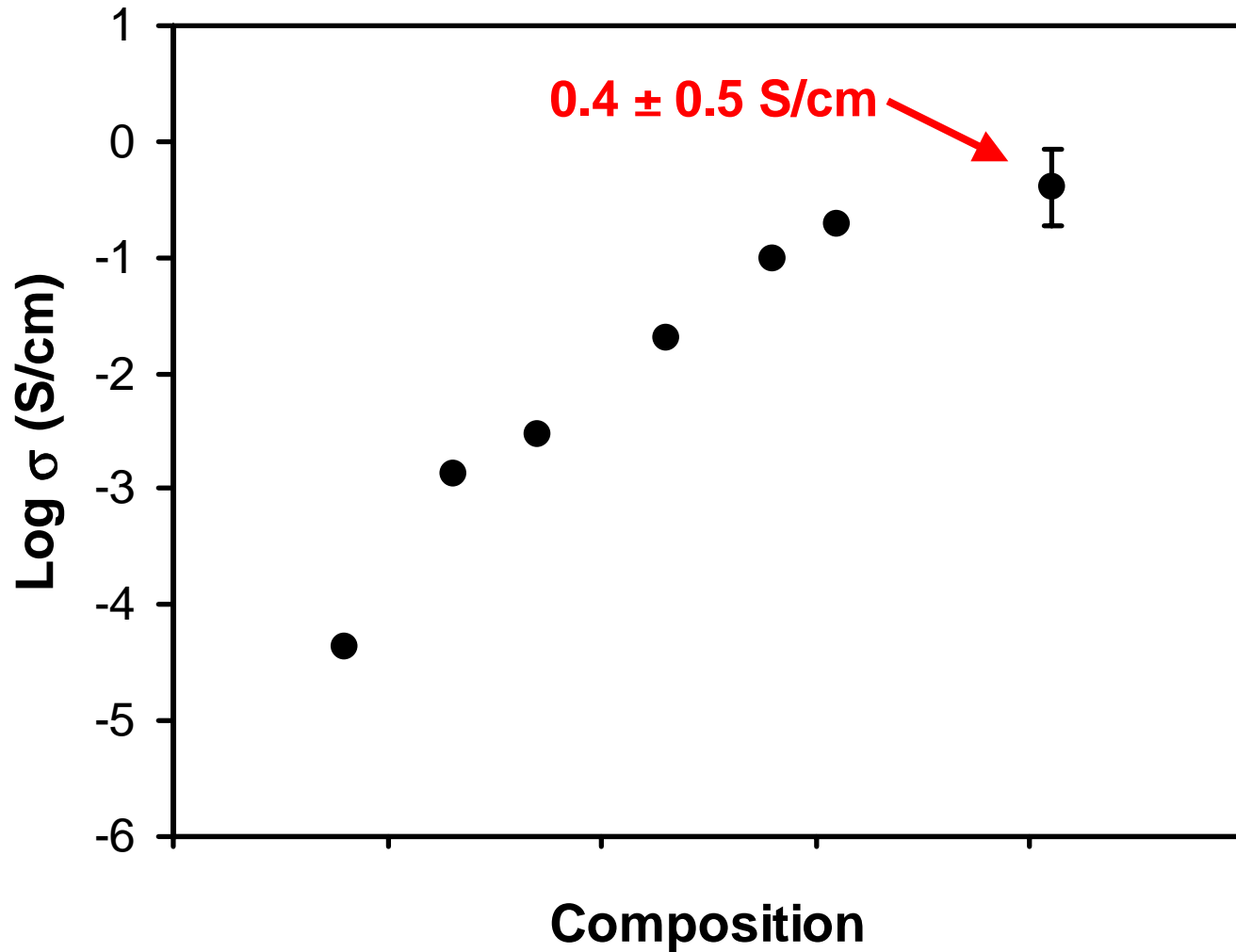
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# Photomicrograph of an ICP Solution

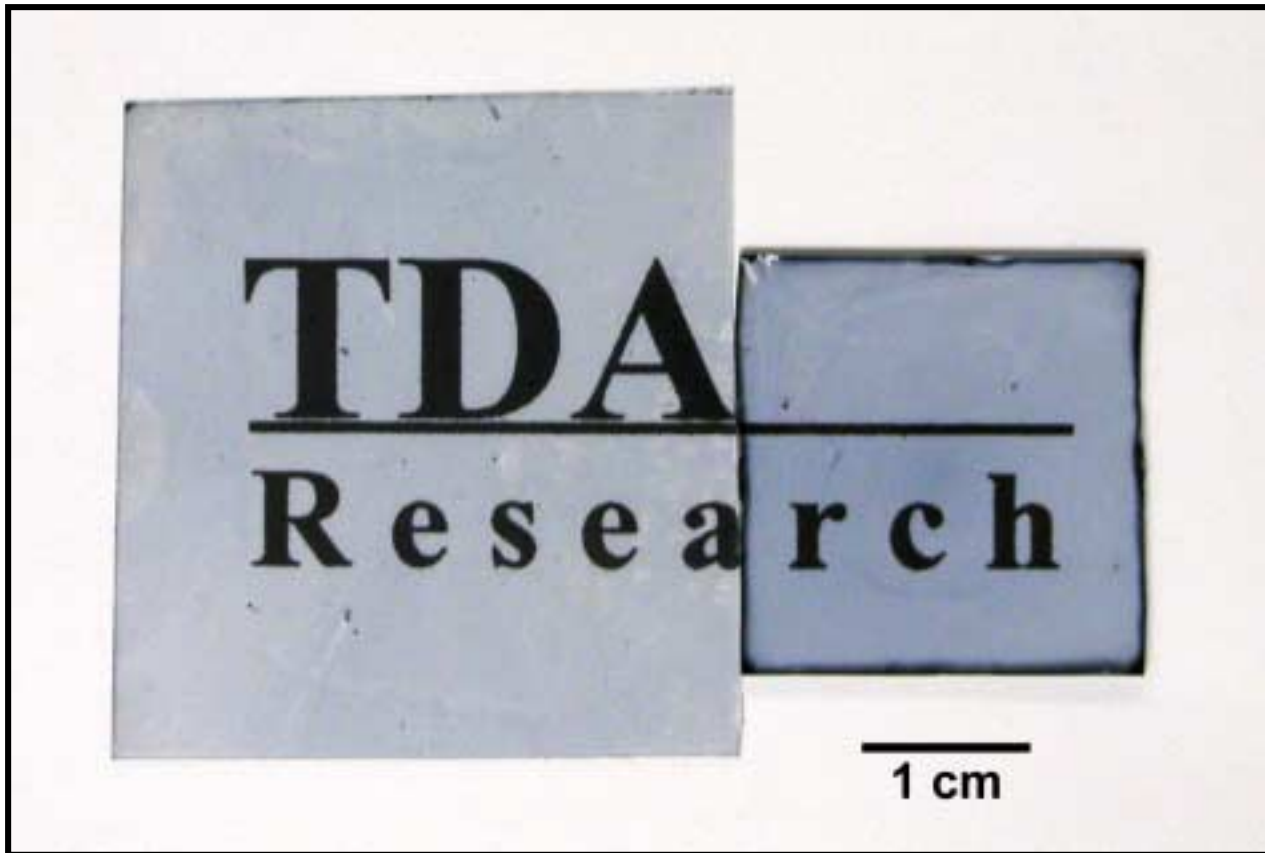


# Bulk Conductivity Trends



# Spin-Cast Films on PET & Glass

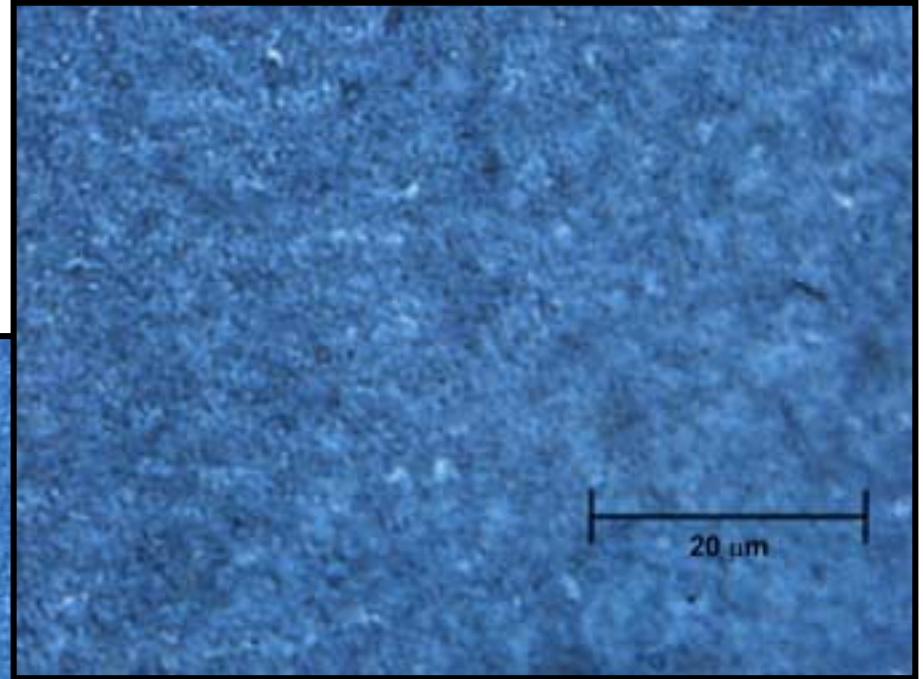
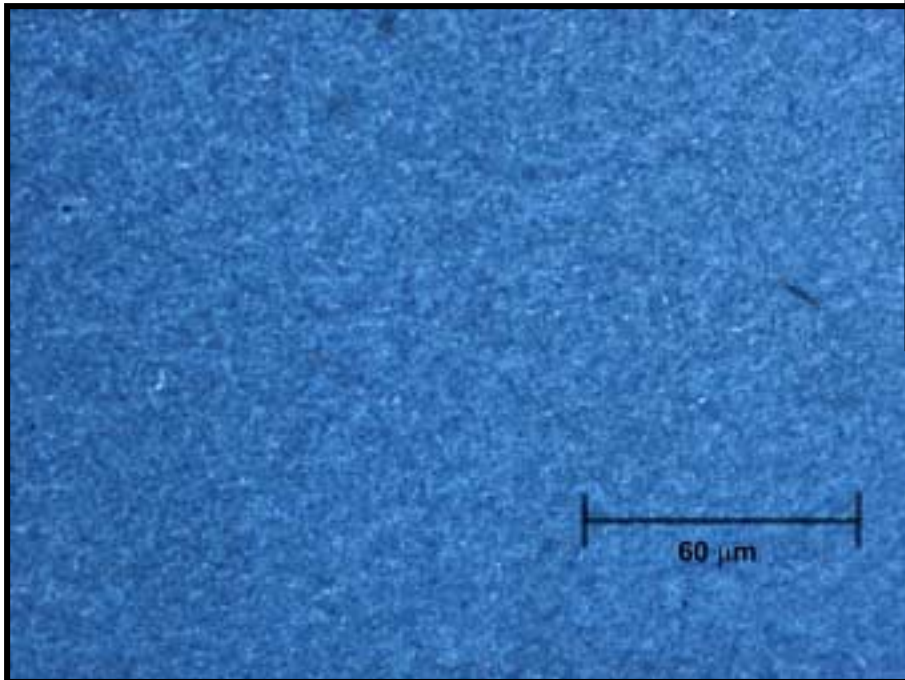
## from Nitromethane



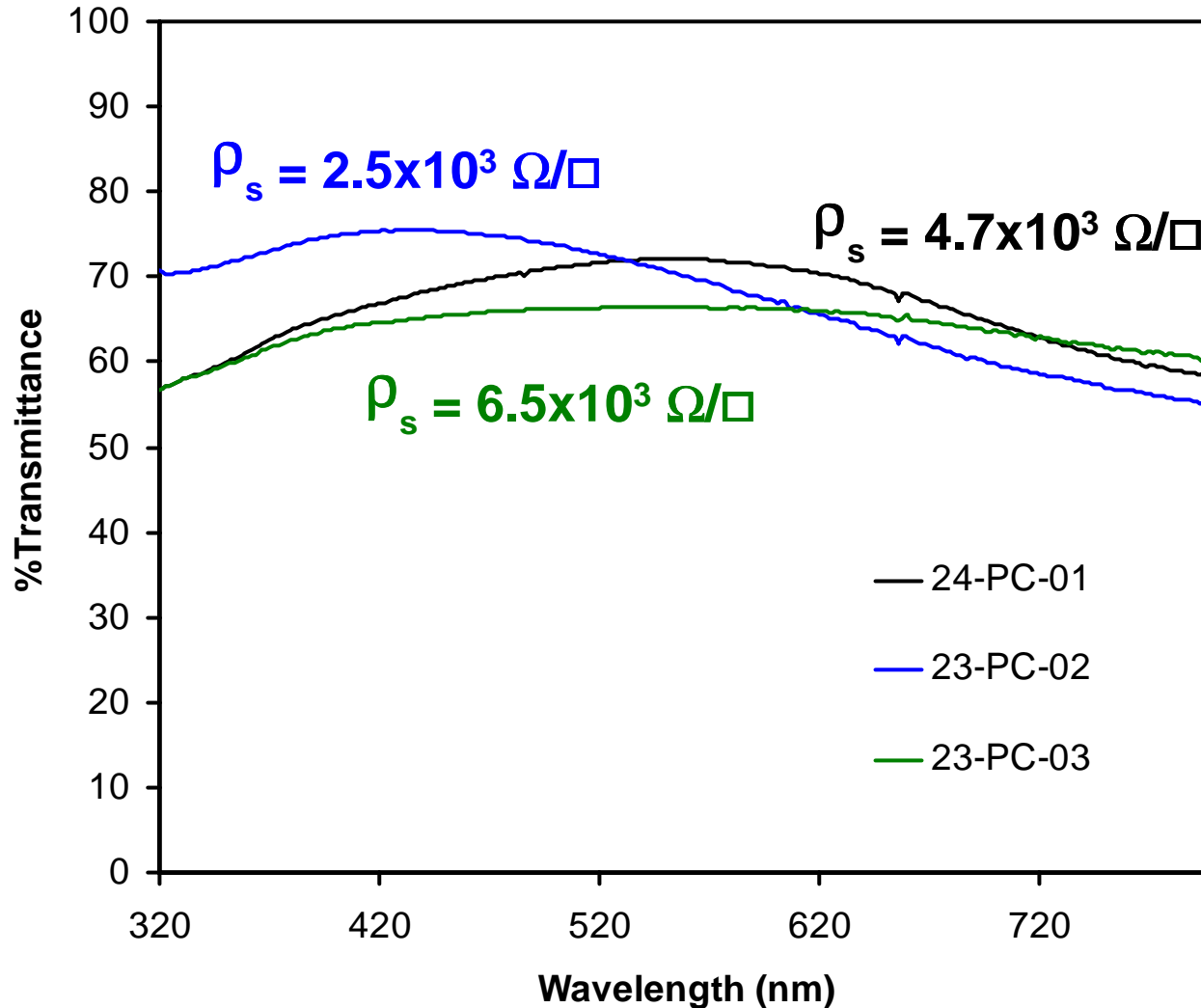
- Films can be spin-cast on PET, PC, and glass without the need for binders
- Films on PET and PC are scratch resistant

# Photomicrograph of an ICP Film

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# Propylene Carbonate-Cast Films on PET



# Summary

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- TDA has successfully developed an organic soluble PEDOT-based ICP
- Bulk conductivity up to 1 S/cm
- Stable gels at 8% wt. solids
- Solutions can be spin-cast into transparent thin-films
- No binders are required
- Good scratch resistance on flexible substrates

# Under Development

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- Polymer blends
- Chemical and photochemical crosslinking
- Extend current methodology to the development of:
  - ICP elastomers
  - Conducting adhesives
  - Soluble polypyrrole-based materials

# Funding

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NSF SBIR Phase I & II,  
NIH STTR Phase I

## Contact Information

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