Laser-induced formation of nanocarbons with tunable morphology directly on polymers

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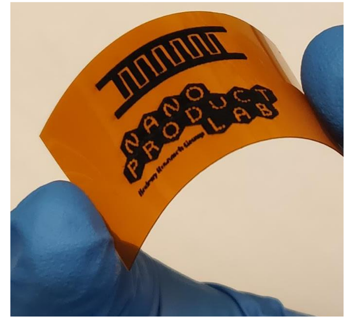
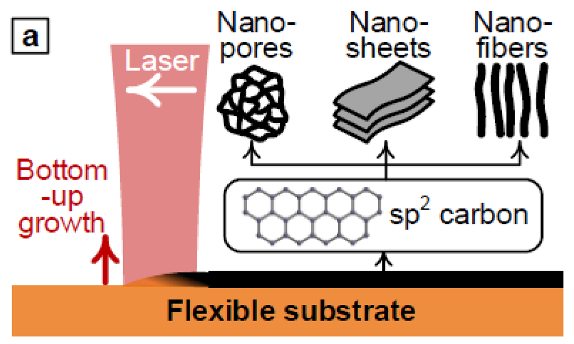


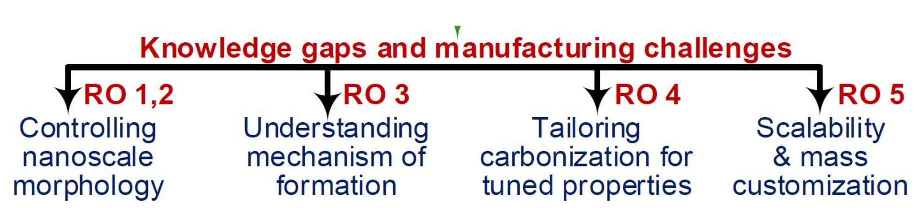
Motivation

- The challenge in flexible device manufacturing: Commercial top-down micro- and nanofabrication technologies were developed largely by/for the semiconductor industry. Hence, they are based on rigid substrates, such as silicon wafers. However, the recent shift toward flexible devices, such as wearable electronics, implantable medical devices, and lab-on-a-chip diagnostics created a global need for new manufacturing processes that are inherently compatible with flexible polymeric substrates that are temperature-limited.



Project Description

- We aim to understand the underlying fundamentals of process of the in Laser-Induced NanoCarbon (LINC) formation and develop its process-structure-property relationships
- Investigating the effect of beam intensity and width on the atomic structure, nanoscale and properties.
- Correlating beam parameters to temperature and heating kinetics using multiphysics simulations.
- Demonstrate tunability of functionality electrodes



Context

- Today, a slew of either direct-write or parallel printing methods are used for fabricating nanocarbon-based structures on flexible substrates.
- Juxtaposition of all these technologies reveals a clear tradeoff between throughput and resolution. The fundamental reason behind this tradeoff is that all printing technologies are based on the transfer of material onto the substrate. Thus submicron resolution requires deposition of femto- to pico-litter volumes with accurate placement.

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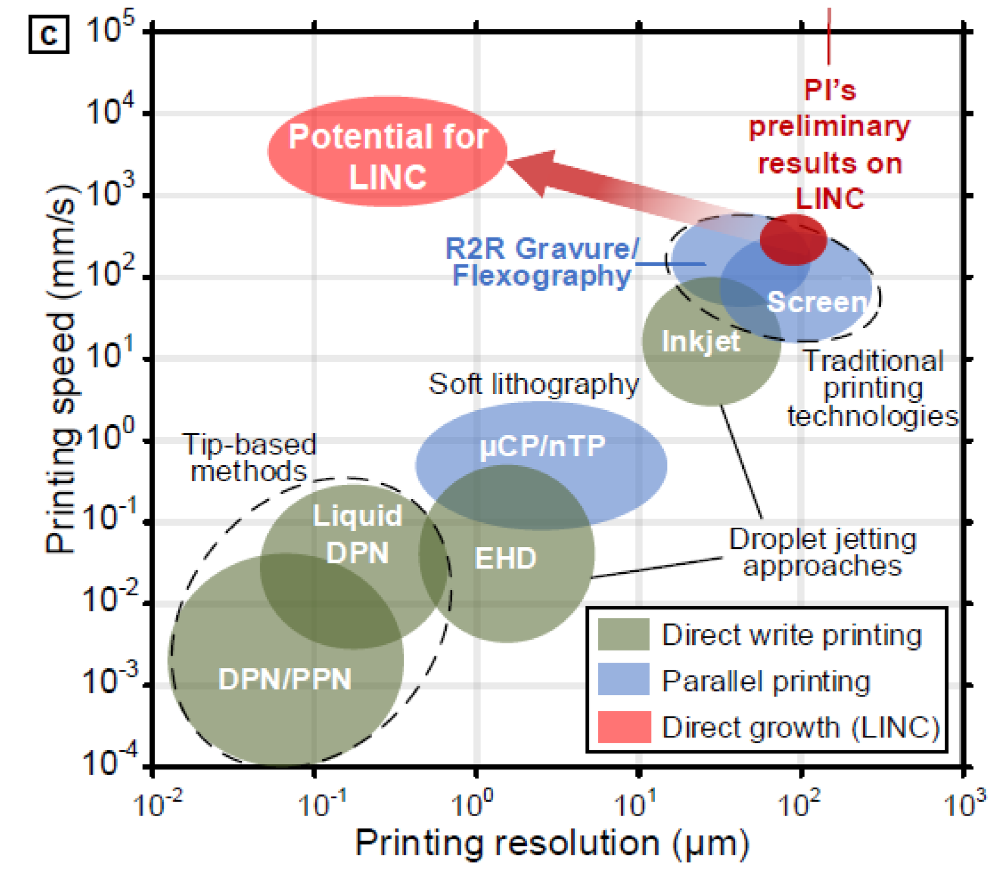
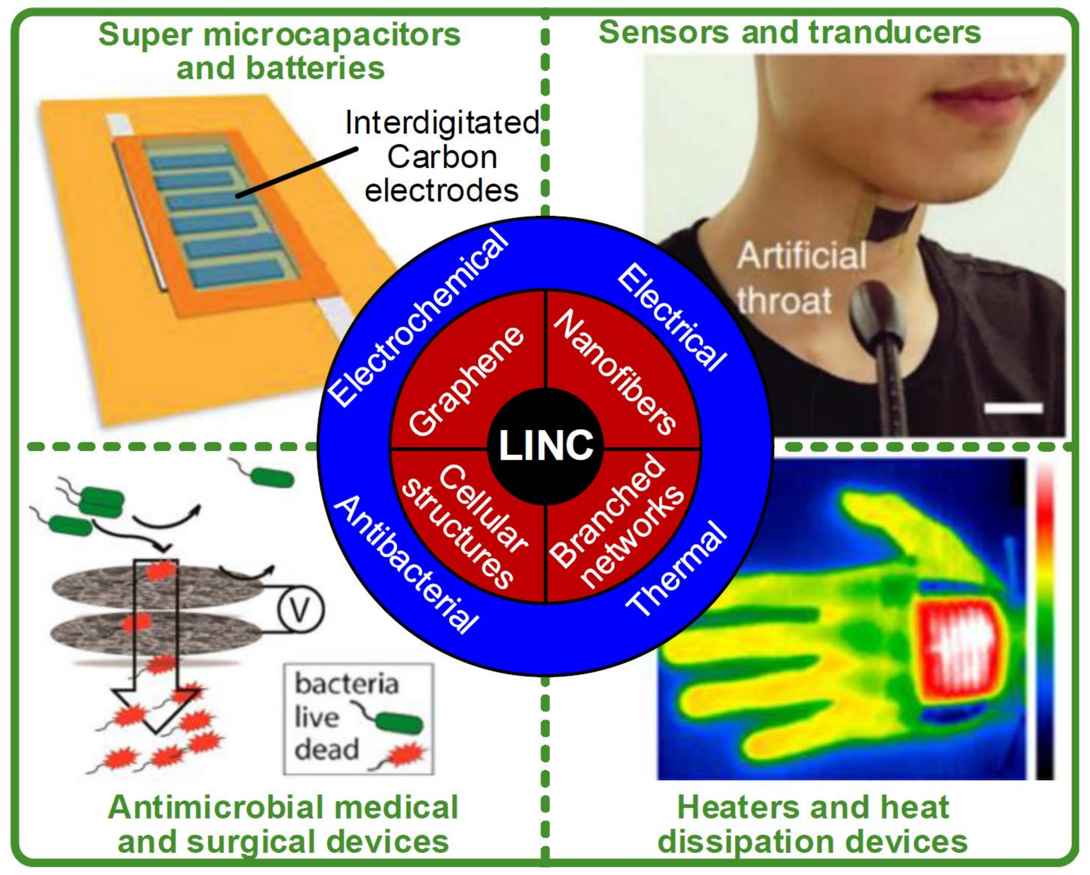
Laser-based bottom-up growth of nanocarbons on polymer films for flexible device manufacturing: An attractive alternative to printing

Potential Impact

- LINC process has the potential to disrupt flexible device manufacturing by replacing printing
- Unique combination of high rate and small resolution



- The proposed research can potentially breaks the limitations of printing by LINC's potential for on-demand control of the atomic structure/properties at specific substrate locations, enabling functionally graded patterns for different applications.



Project Deliverables

- Milestone 1: Submitting one journal article on experimental parametric study (5/1/20 – 9/1/20)
- Milestone 2: Generating multiphysics modeling results (9/1/20 – 12/1/20)
- Milestone 3: Submitting one proposal to NSF (12/1/20 – 2/1/21)
- Milestone 4: Submitting a second journal article with integrated experimental and modeling (2/1/21 – 5/1/21)
- Milestone 5: Submitting NSF CAREER proposal (5/1/21 – 7/15/21)

Acknowledgements

- PhD student Moataz Abdulhafez

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