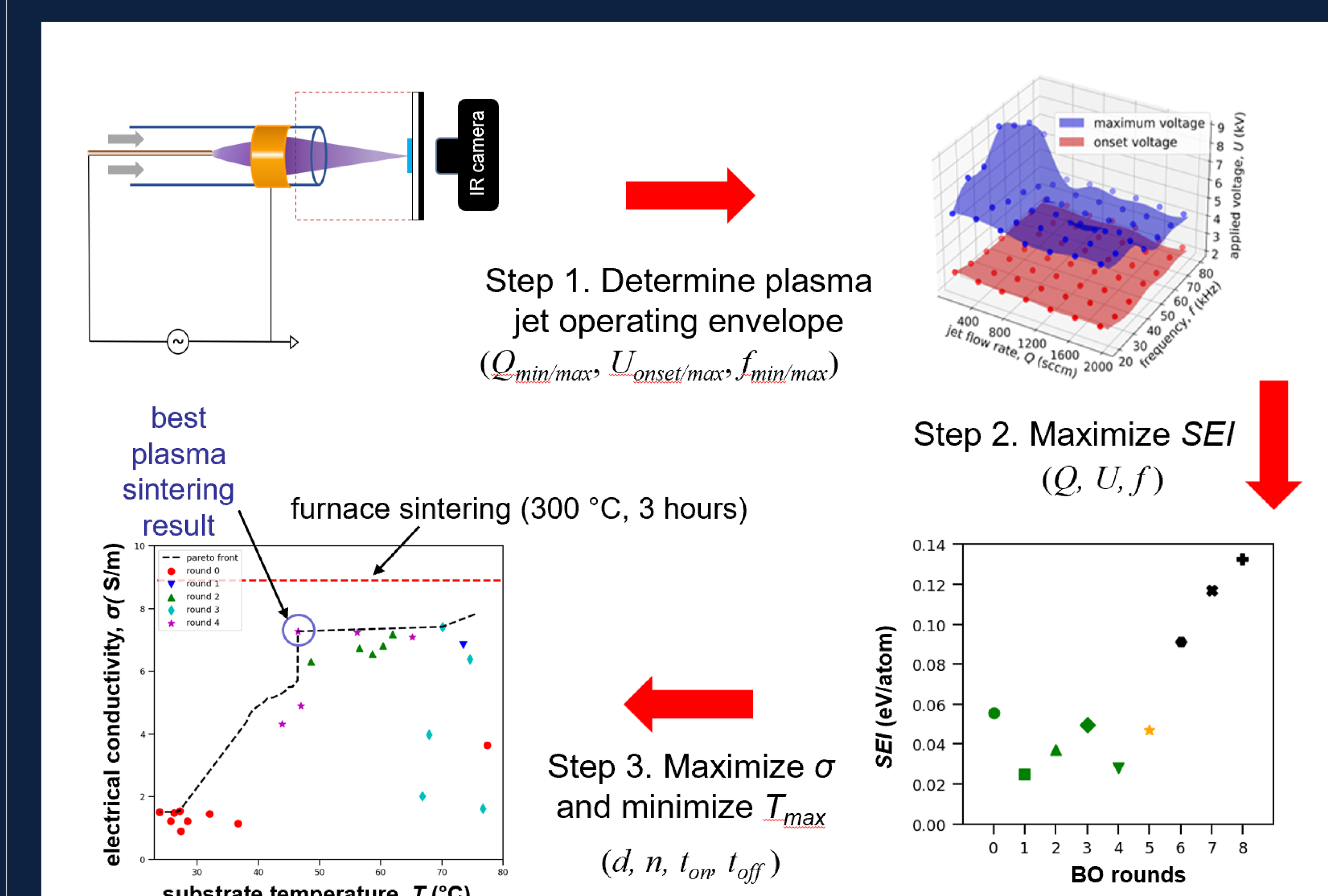
# Accelerating Low-temperature Processing of Printed Nanoinks Using Machine Learning and Bayesian Optimization of Non-thermal Plasma Jet Sintering

Zhongyu Cheng, Ke Wang, Ali N. M. Tanvir, Wenjie Shang, Yanliang Zhang, Tengfei Luo, Alexander W. Dowling, David B. Go
University of Notre Dame

## Motivation

- Rapid processing of emerging nanomaterials on flexible and thermosensitive substrates for applications in wearable electronics and *in situ* sensors
- Non-thermal plasma jets enable simple and low-temperature sintering of printed thin films on delicate substrates[1,2]
- Machine learning Bayesian optimization (BO) approaches optimize multi-dimensional experimental problems in a low-cost and efficient way[3]

## Optimization Workflow & Results




Objectives:
- ➢ maximize electrical conductivity ($\sigma$) of ITO thin films
- ➢ minimize the peak substrate temperature ($T_{max}$)

- Decision variables: $Q, U, f, d, n, t_{on}, t_{off}$
- BO increases SEI by 2.4×
- Pareto front indicates the best trade-off between $\sigma$ and $T_{max}$

## Summary

- Bayesian optimization method optimized 7-dimensional variable space to maximize the electrical conductivity of ITO films and control the substrate temperature under a relatively low value
- Non-thermal plasma jet sintering of ITO produced a conductivity of 7.6 S $m^{-1}$ with a substrate temperature below 47 °C in 1 hour
- Achieved 81.4% of furnace sintering with a temperature 250 °C lower and 3× faster

**References**

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