

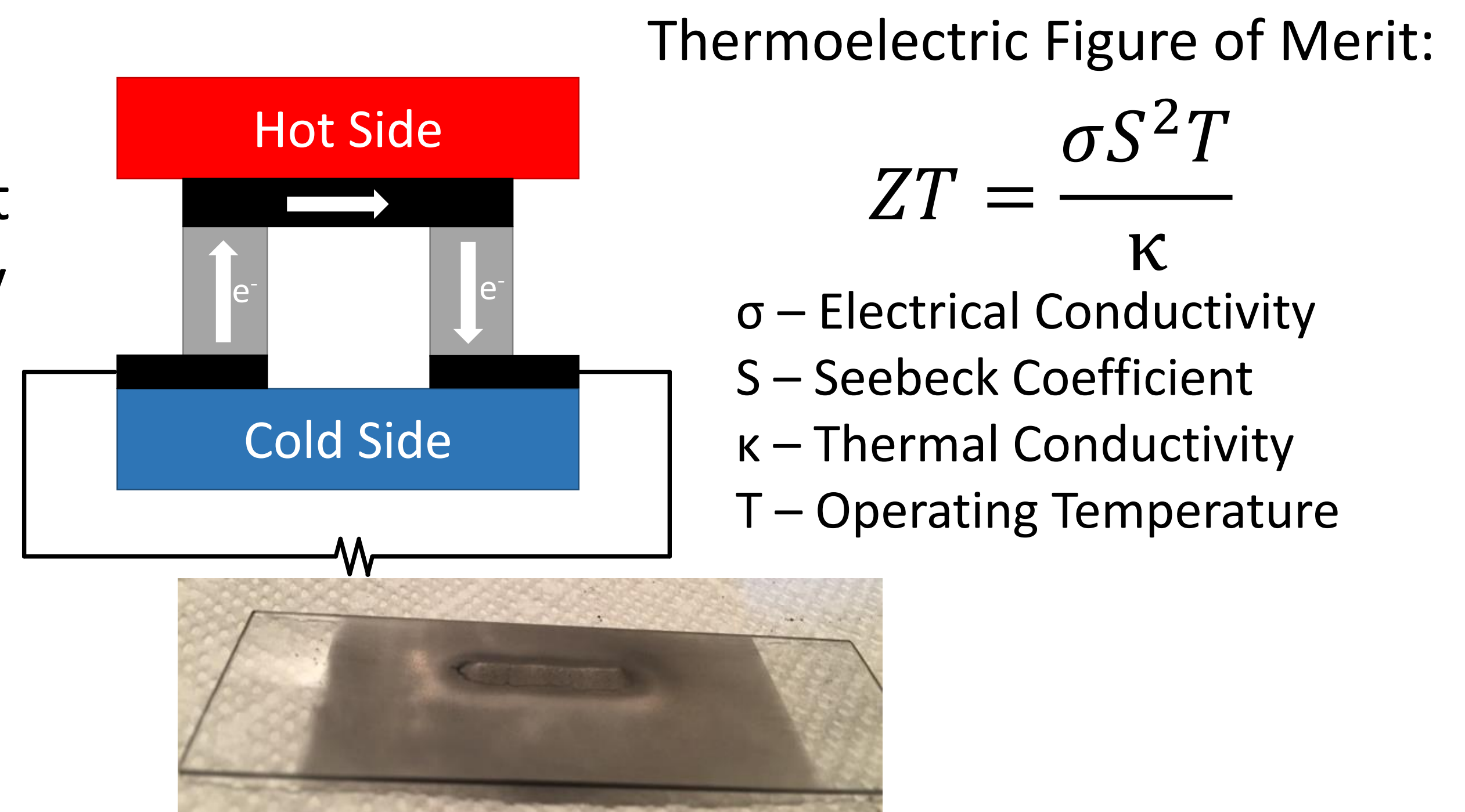
Cold Spray Additive Manufacturing of Thermoelectric Generators

Alexander A. Baker¹, Richard Thuss², Elissaios Stavrou¹, Joe M. Zaugg¹, Scott K. McCall¹, Harry B. Radousky¹

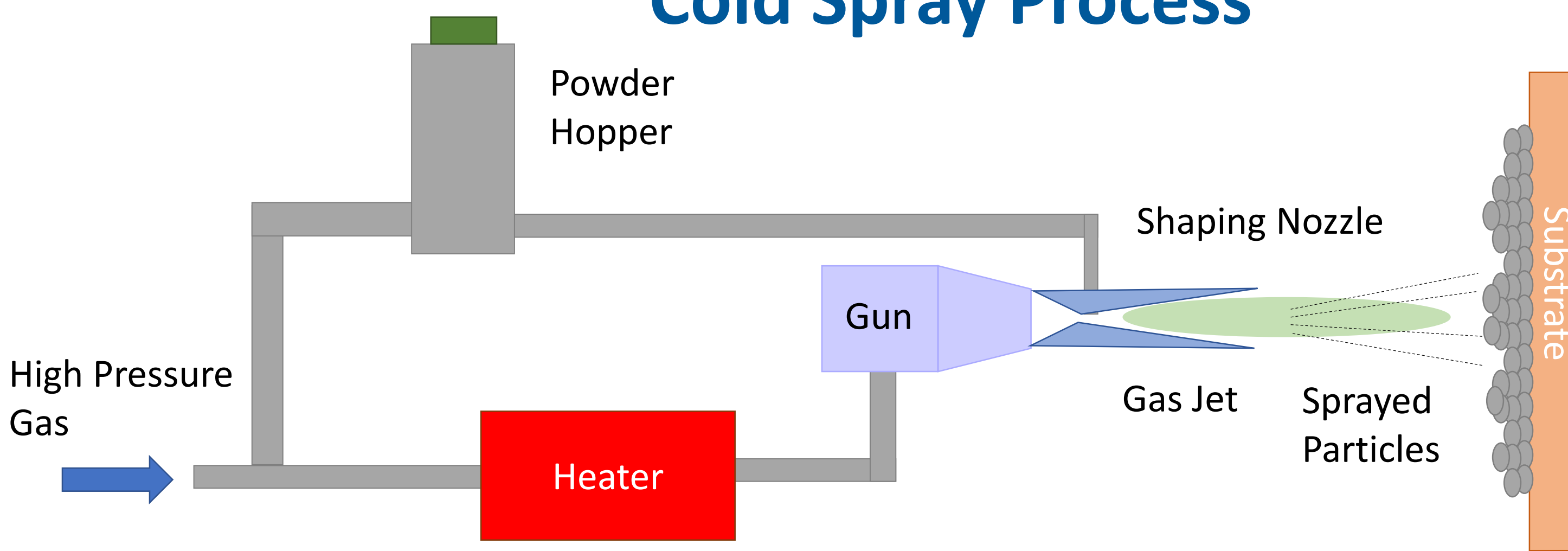
1: Lawrence Livermore National Laboratory, 7000 East Avenue, Livermore, CA, 94566. 2: TTEC Thermoelectric Technologies, Wickliffe Road, Berryville, VA 22611

The Need for Thermoelectric Generators

- Over 20% of industrial inputs in the US are lost as waste heat
- Thermoelectric generators (TEGs) convert this to electricity
- Harvesting low-grade waste heat provides a free, inexhaustible resource



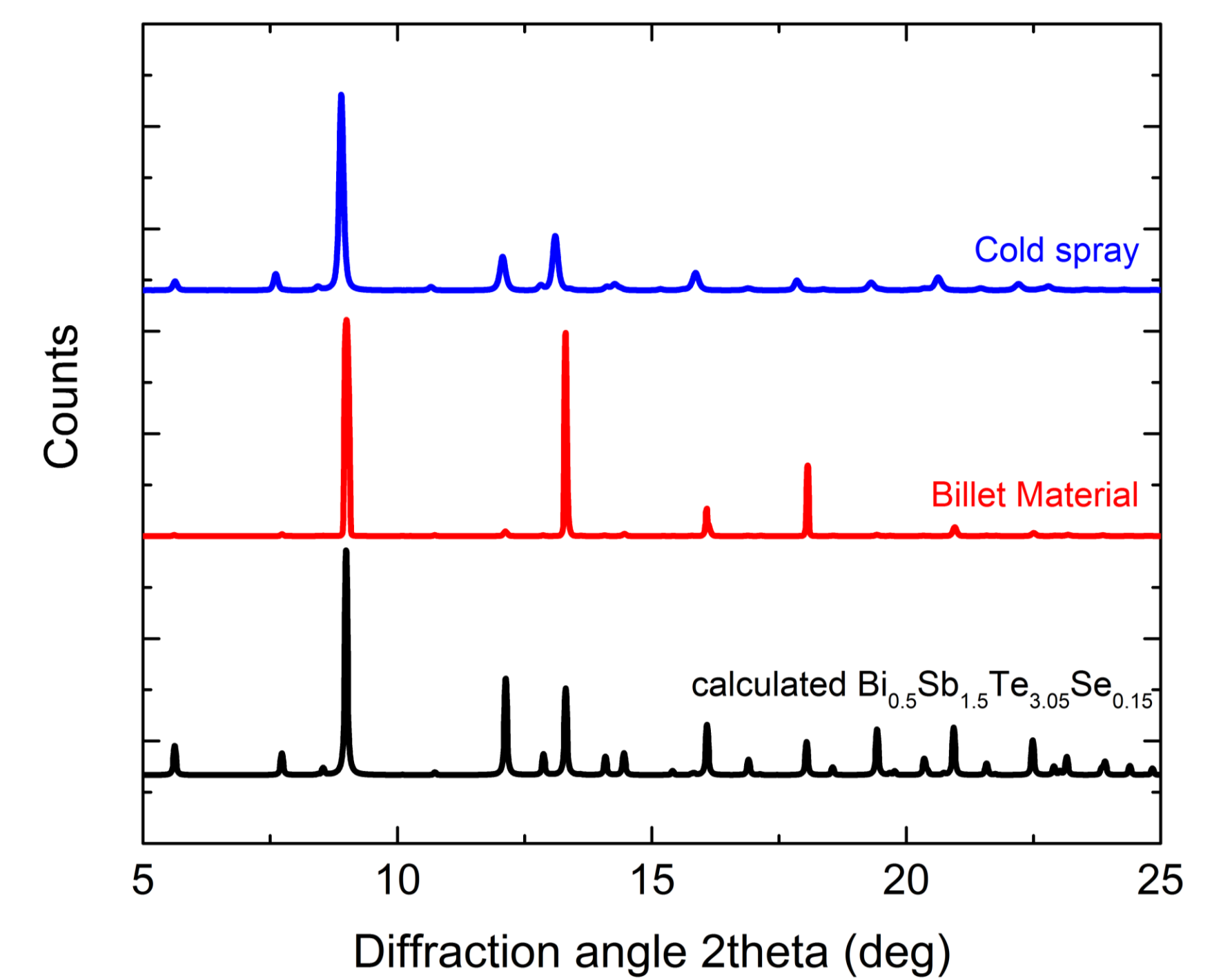
Cold Spray Process



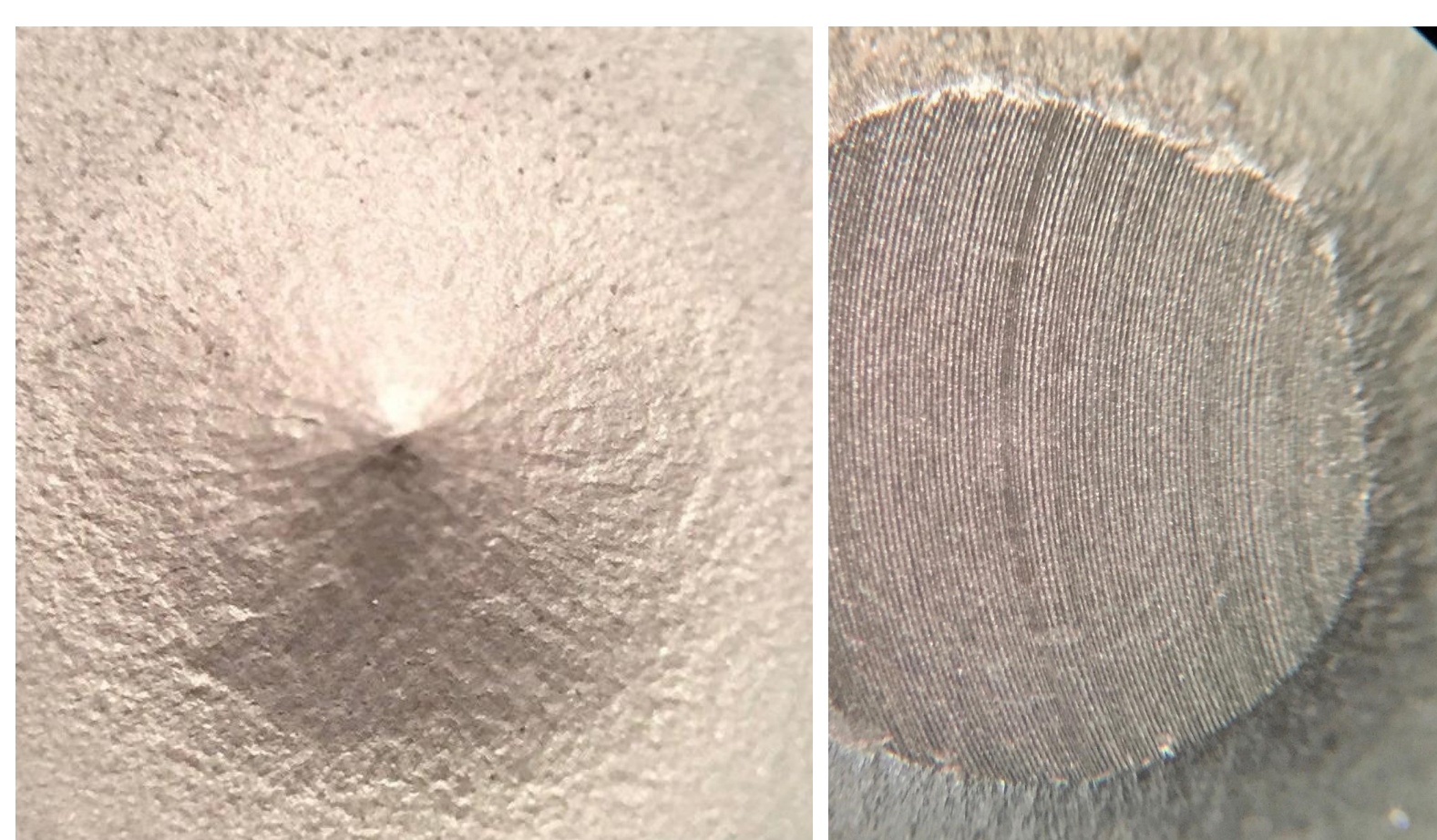
We are developing cold-spray deposition of Bi₂Te₃ for applications in heat harvesting in complex geometry parts

Benefits of cold spray additive manufacturing include:

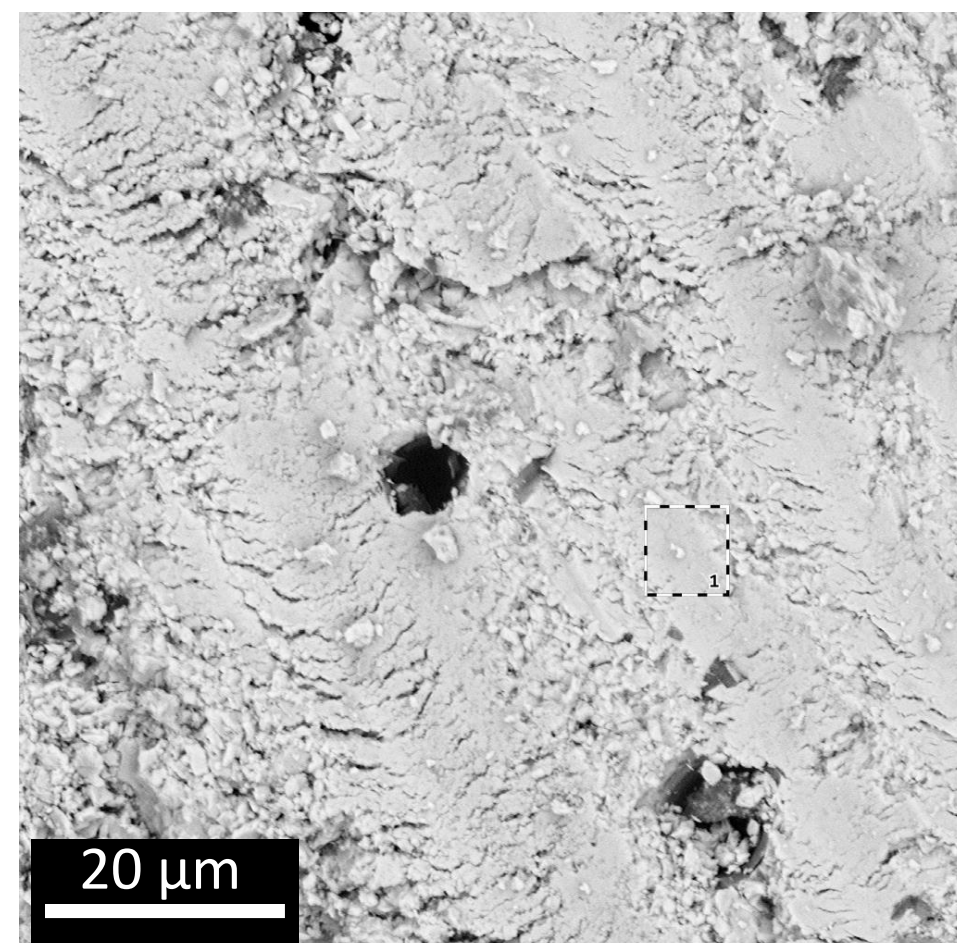
- Applicable to a wide variety of materials
- Control of residual stress improves fatigue life
- Free particles can be collected and reused
- Ability to deposit on curved surfaces



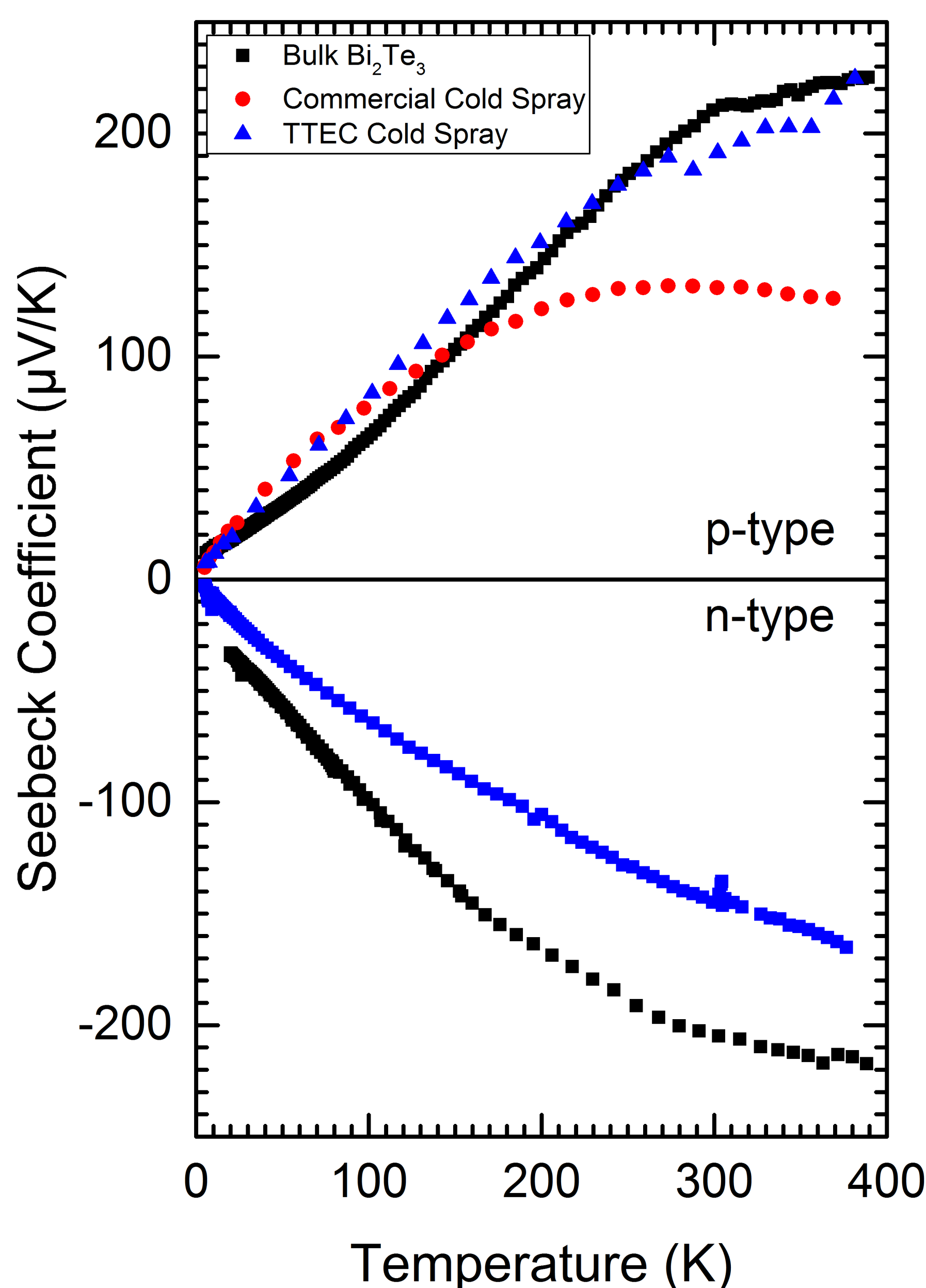
Sprayed material is composed of randomly oriented crystallites



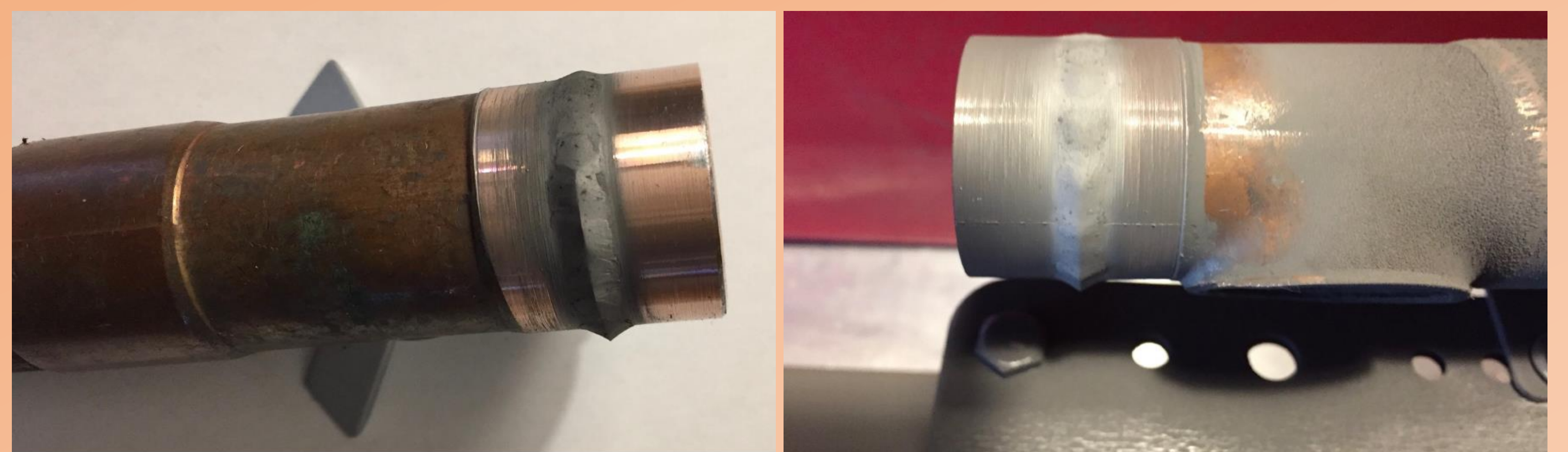
Uniform deposition throughout structure



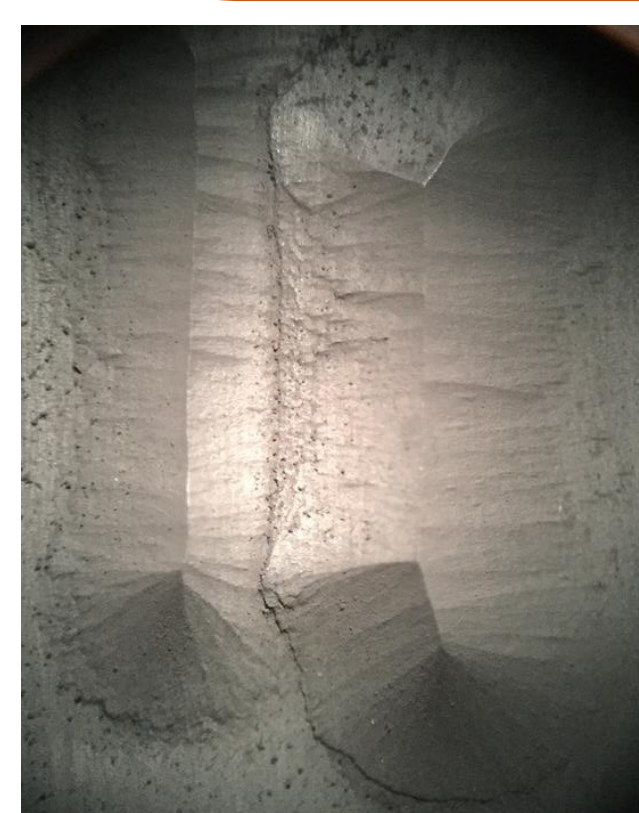
Multi-layer structures show good interfaces



High Quality Deposition Achieved on Copper Pipes



Pathway to complex geometry TEGs to harvest low-grade waste heat
Opportunity to extend to wide range of industrial processes



Future work includes:

- Improving efficiency of deposition
- Development of multi-component layered structures
- Extension of deposition technique to more TE materials