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NANO-ENABLED MICROINDUCTORS FOR POWER ELECTRONICS

ERIC LANGLOIS, PH.D. | SANDIA NATIONAL LABORATORIES

INNOVATE NEW MEXICO®
TECHNOLOGY SHOWCASE

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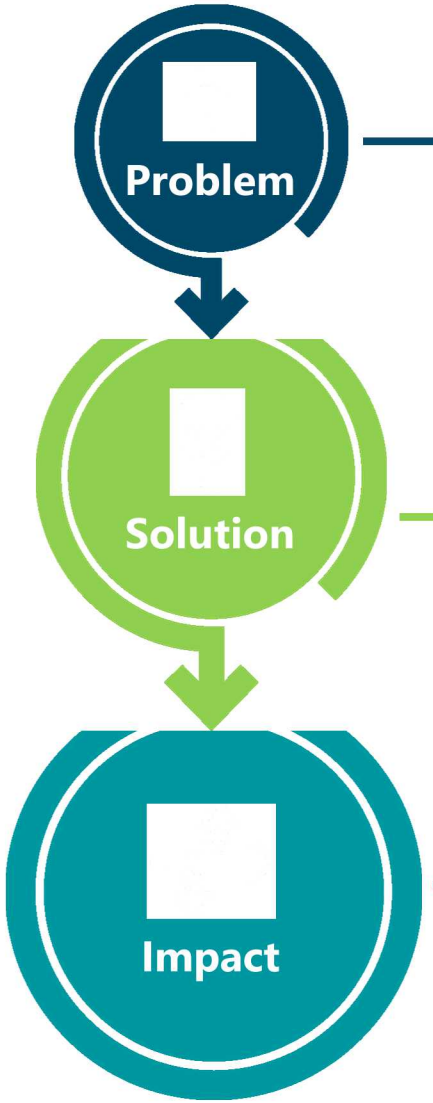
BACKGROUND

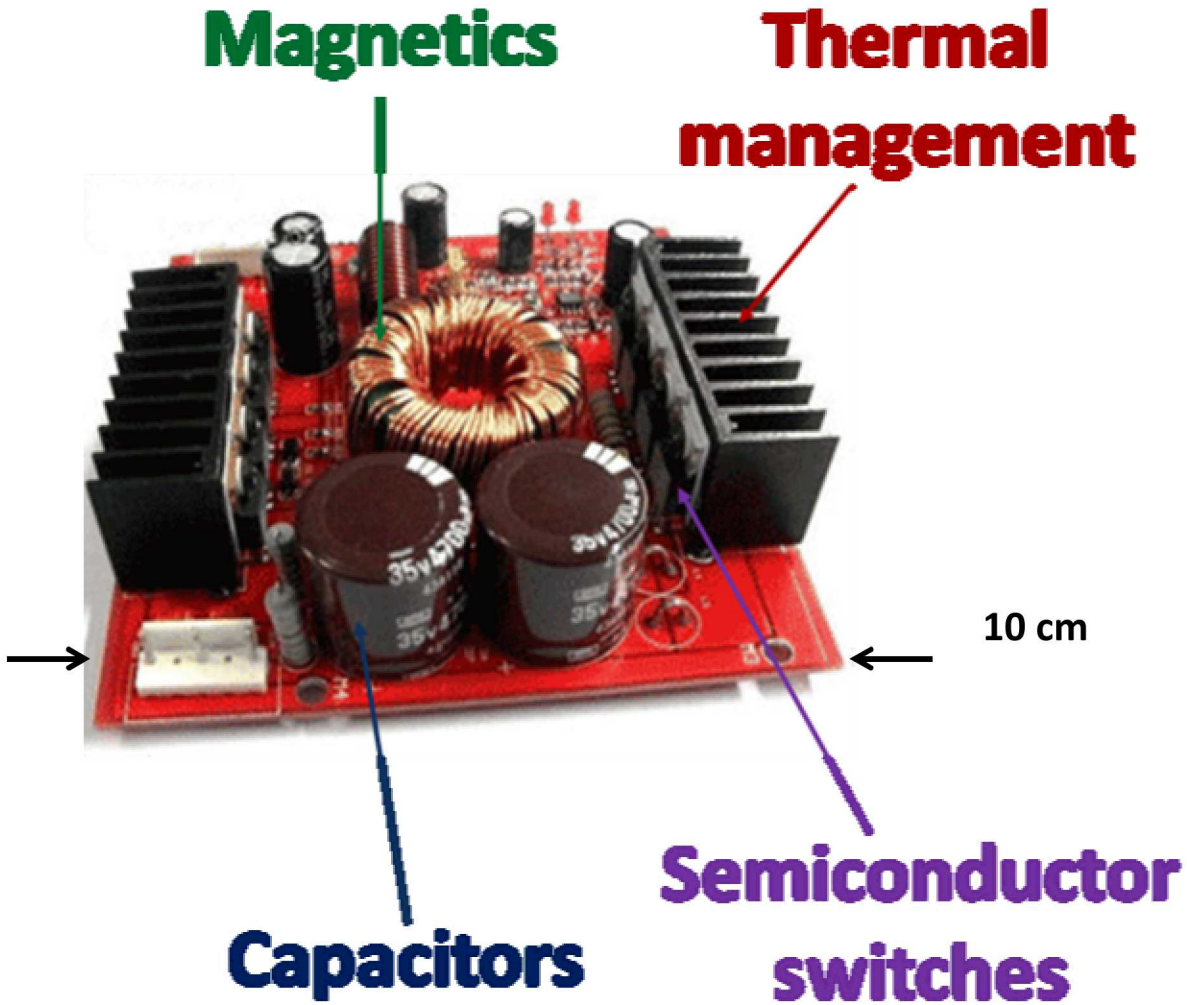


Scaling of magnetic passive components has not kept pace with advances in high power semiconductor devices

Power Converter on Chip (PCoC)

Reduced power converter size and weight, lower cost, enhancements in manufacturability and reliability

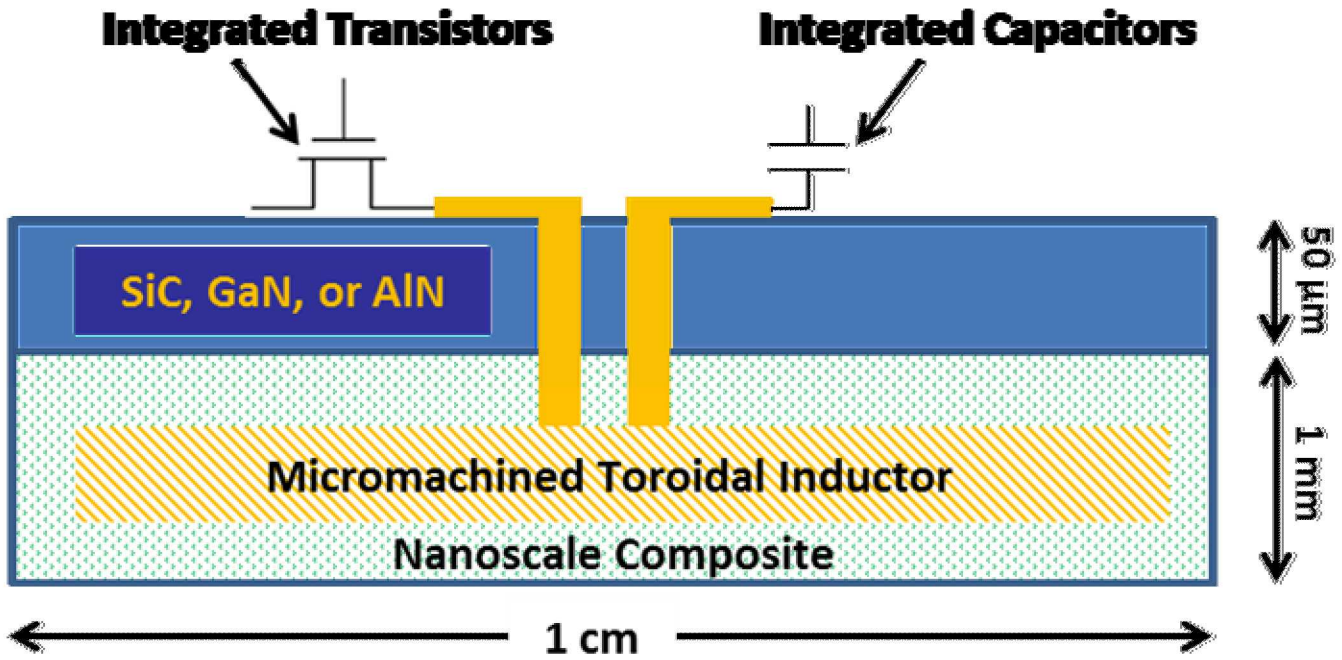
Background



Status Quo

Discrete components on Printed Circuit Board (PCB)

Background

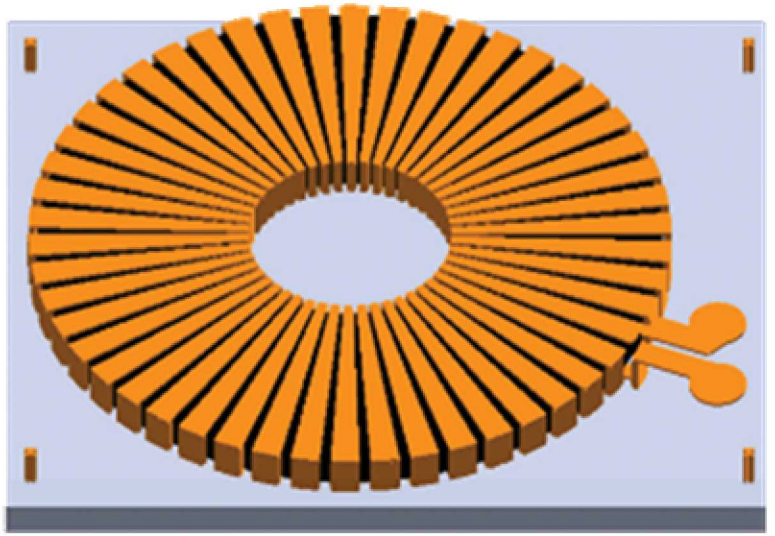


Future State

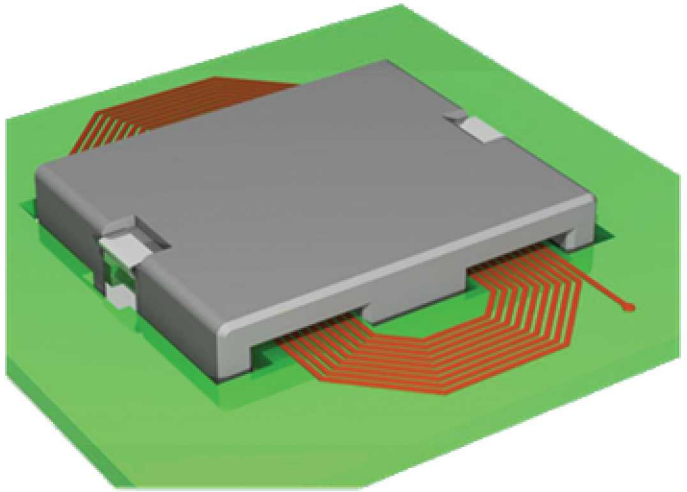
Power Supply on Chip (PSoC)

INNOVATION

- **Superparamagnetic iron/iron-oxide nanoparticle composite core material.**
  - Zero hysteresis and eddy current loss → enables higher frequency (1MHz) switching.
  - CMOS & III-V backend compatible (low temperature (< 60°C) processing, 3D liquid-to-solid molding).

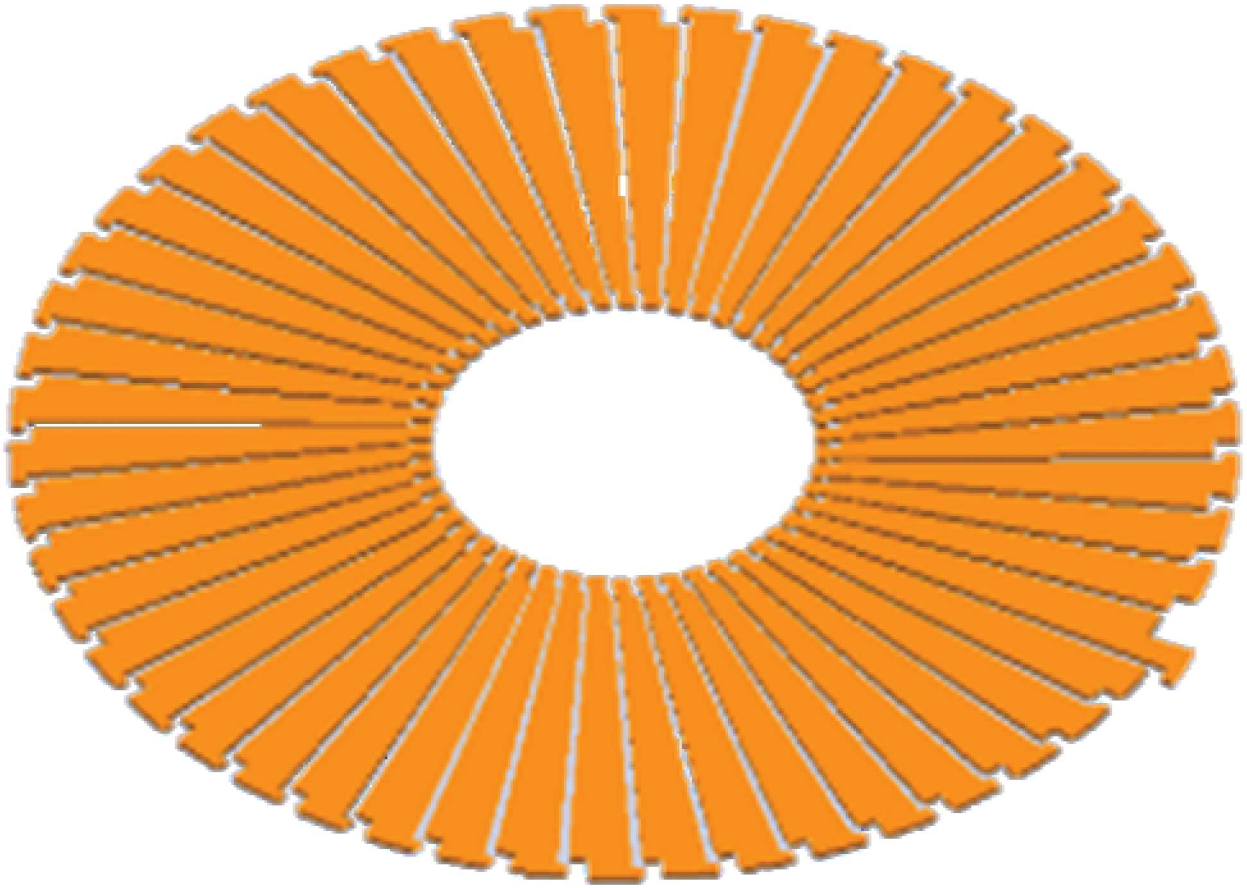


- **MEMS processing and other novel fabrication techniques.**
  - (MEMS Micromachining) optical photolithography, electroforming, e-beam metal evaporation.
  - (Novel Techniques) 3D printing (molds, wires), femtosecond laser drilling (nanocomposite), potting epoxy.



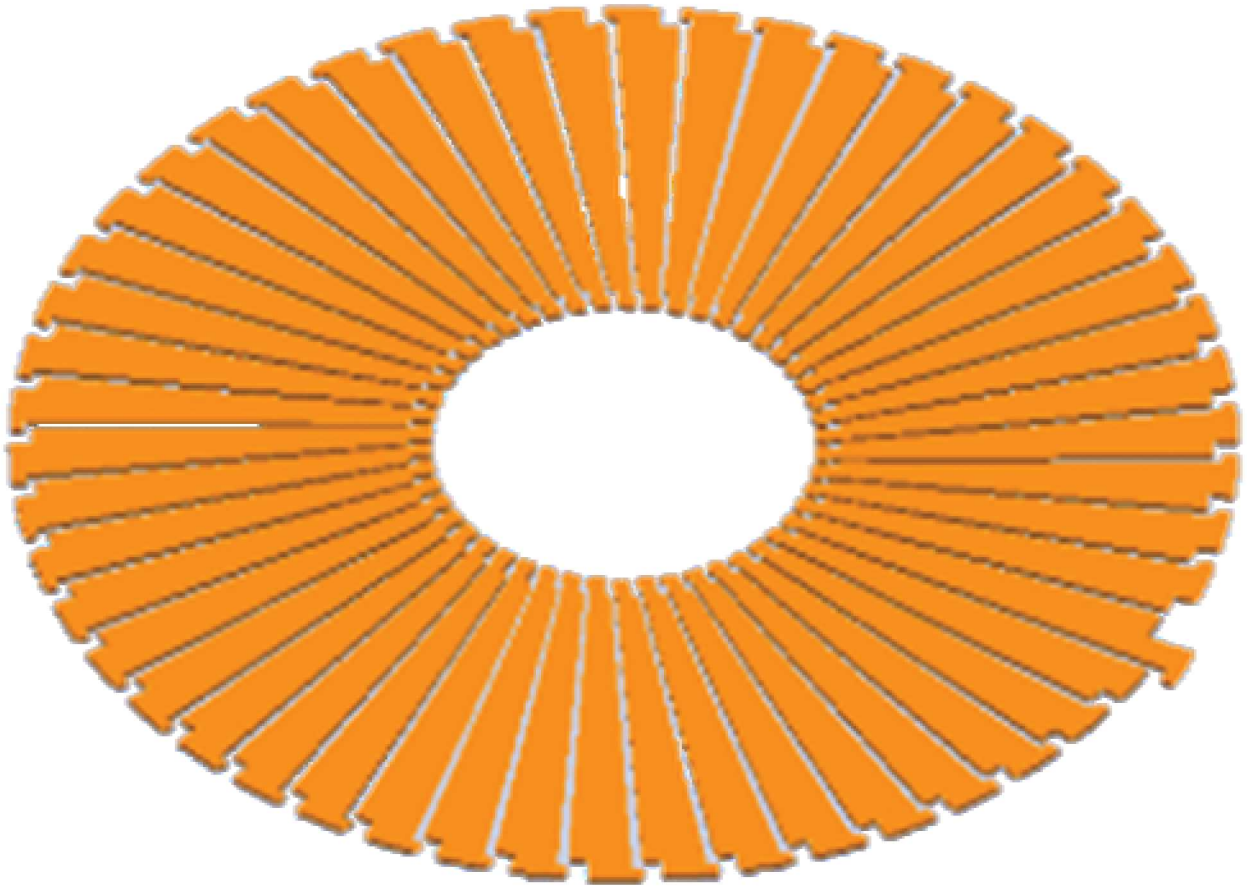
Planar Microinductor

INNOVATION – 3D CAD Design



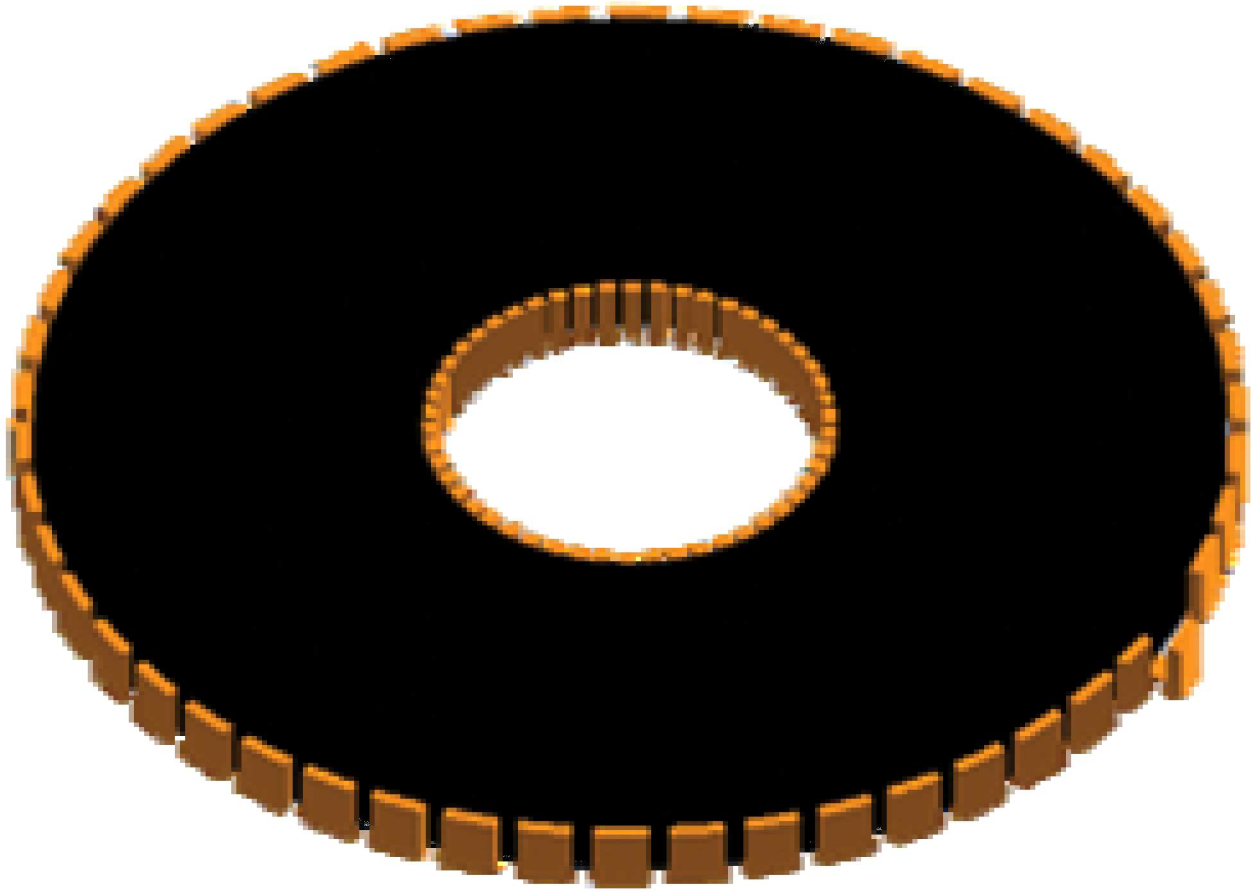
50 μm Electrodeposited Bottom Cu Layer

INNOVATION – 3D CAD Design



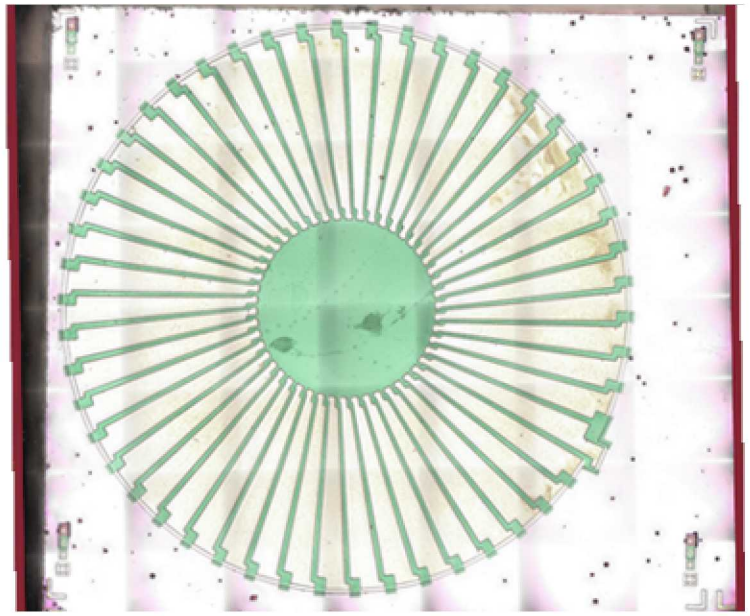
3D Printed Cu Via and Nano-Core Mold

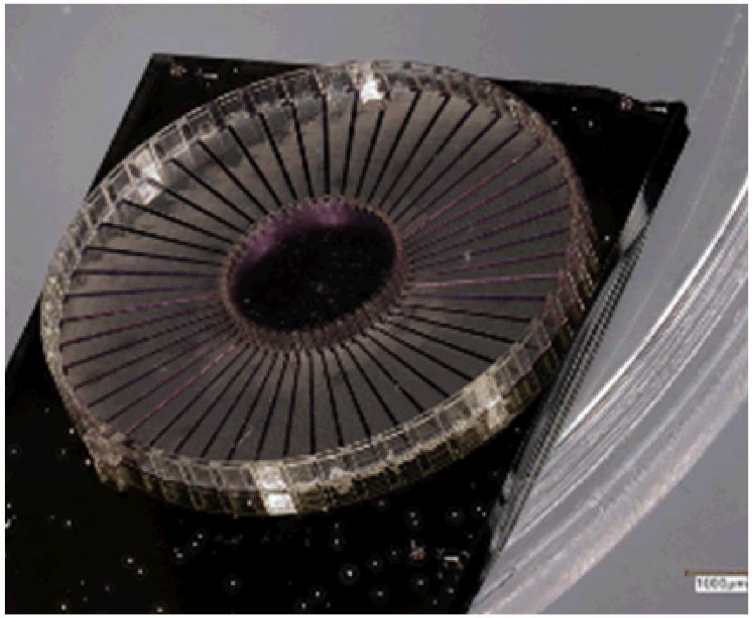
INNOVATION – 3D CAD Design

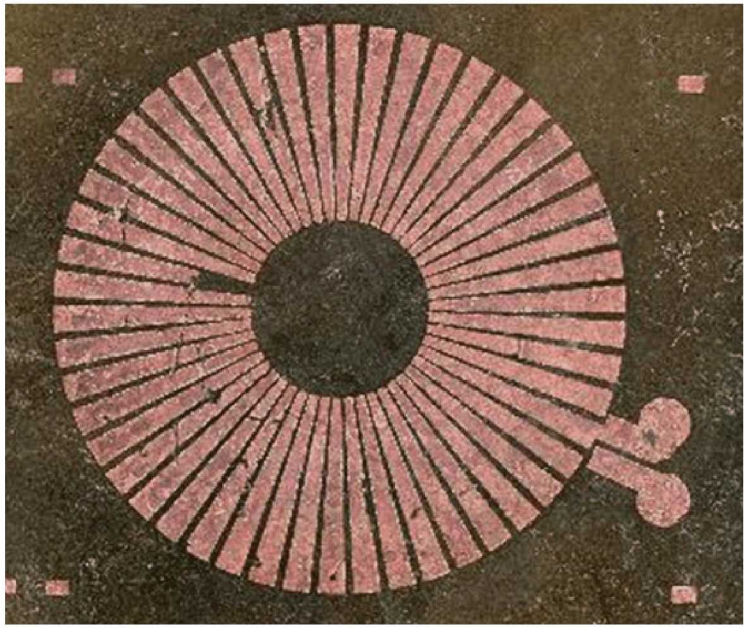


50 μm Electrodeposited Top Cu Layer

INNOVATION – Current Fabrication Status







APPLICATIONS

RESEARCH

- Power electronics

GOVERNMENT

- DoD power bus systems (missiles, aircraft, ships, drones, etc.)

INDUSTRY

- Stand-alone microinductors and transformers for power electronics

BOURNS®

- Integrated microinductors/transformers for chip-scale power converters

ANALOG DEVICES

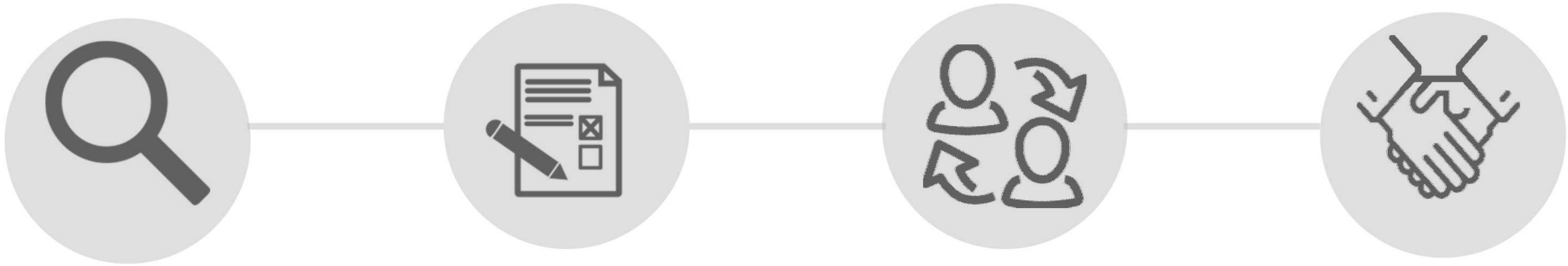
LINEAR TECHNOLOGY

NEED/MARKET POTENTIAL

The worldwide market for Chip Power Inductors is expected to grow at a CAGR of roughly ***4.2%*** *over the next five years, will reach $1.2B in 2024, from $940M in 2019*

- Market Watch

STATUS



1. LDRD	2. IP Protection	3. Maturation	4. Partnerships
Proof of Concept	SD#15171 SD#15172	Process Development	Deployment
	USPTO Patent Application		

QUESTIONS