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Wireless and Microsystem Power Components

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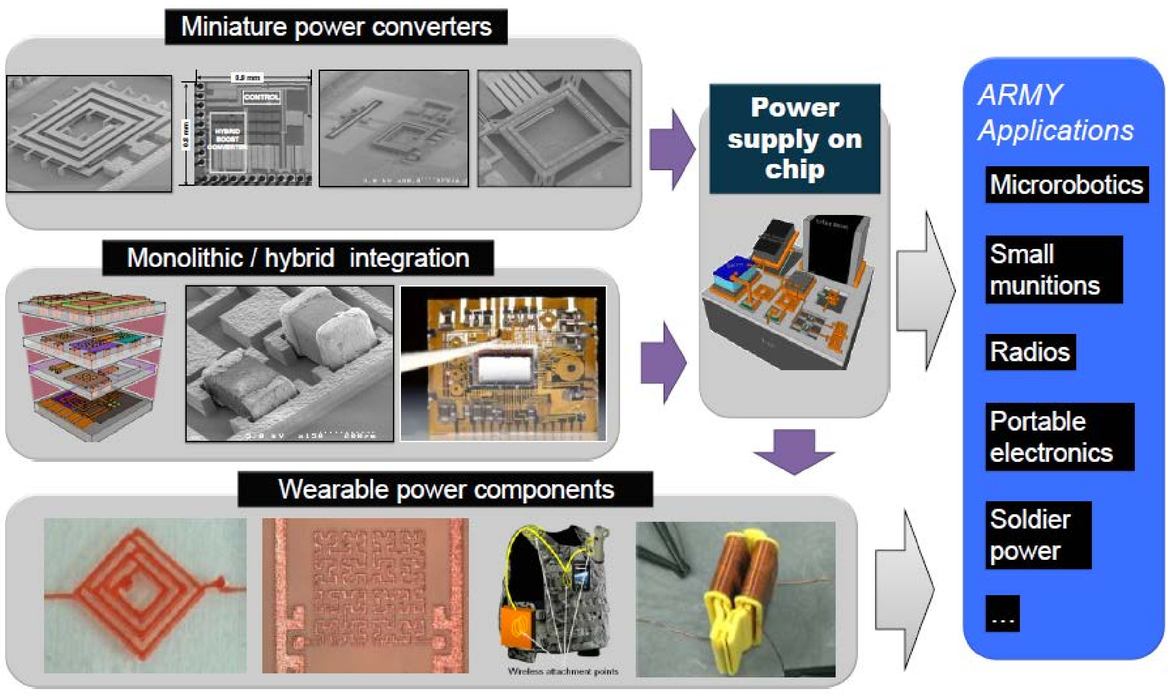
S&T Campaign: Materials Research
Energy & Power

Research Objective

- Develop components and topologies to tightly integrate power management at the individual points of load in handheld and smaller electronic devices
- Enable loosely coupled, wireless power distribution amongst multiple, freely moving devices



Establishing innovative microfabrication and integration/assembly processes to create high performance integrated power components

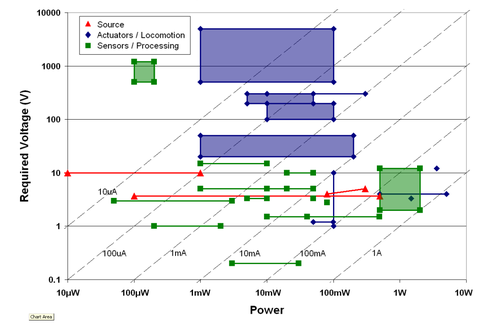
Challenges

Chip-scale Components for Power Management:

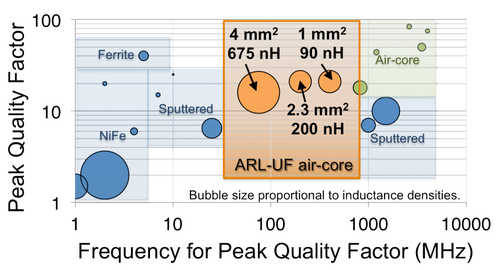
- Parasitic capacitances and inductances comprise sizeable portion of switched impedance at very high frequencies
- Fabrication of power components with tight (<1 µm) tolerances requires precise characterization and control of equipment

Wireless Power for Power Distribution:

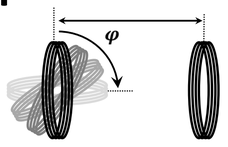
- Varying coupling coefficient between transmitter and receiver pair requires adaptable impedance matching to maintain high efficiency and levels of power transfer

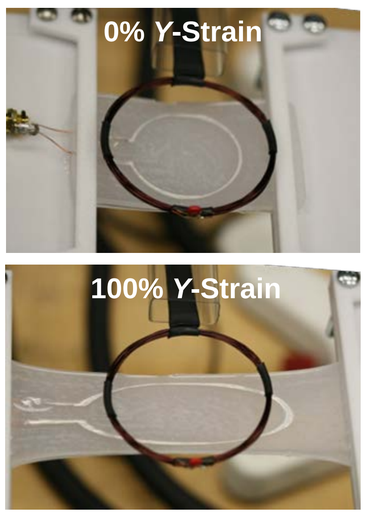


Survey of microsystem power needs



Microinductor performance state-of-art

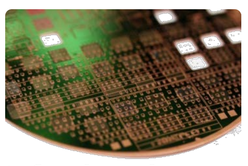




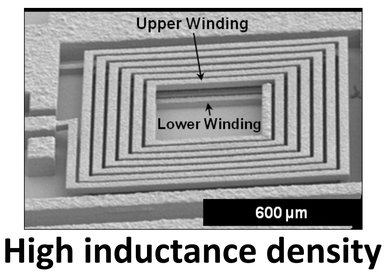
Wireless power in dynamic systems

ARL Facilities and Capabilities Available to Support Collaborative Research

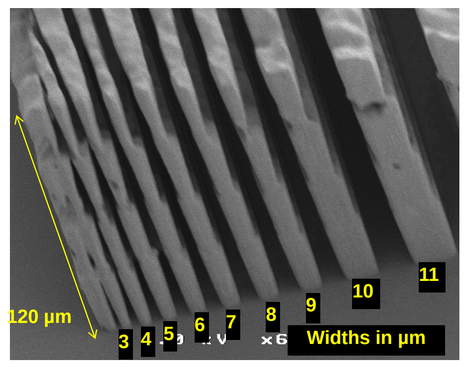
- 3D multilayer metallization process with thick films (up to 30 µm) and high aspect ratios (up to 10:1) in copper
- Thin film sol-gel PZT & multi-layer metal integrated process for novel MEMS devices
- Thin-film electroplating processes and characterization
- Broad spectrum (5 Hz – 3 GHz) network analysis of wireless power topologies and high frequency, integrated passive power components
- Liquid metal, stretchable, conductive traces and inductors in embedded in multilayer silicone elastomer channels
- High accuracy pick-and-place tools for heterogeneous electronic integration
- N Lazarus, et al., "Multilayer liquid metal stretchable inductors," Smart Materials and Structures, 2014
- SS Bedair, et al., "High-performance micromachined inductors tunable by lead zirconate titanate actuators," IEEE Electron Device Letters, 2012
- CD Meyer, et al., "High-Inductance-Density, Air-Core Power Inductors and Transformers Designed for Operation at 100-500 MHz," IEEE Trans. Magn., 2010



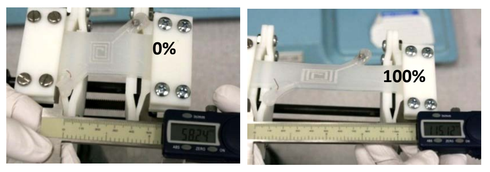
Wafer level MEMS integration



High inductance density air core magnetics



High-aspect-ratio multilayer metal



Liquid metal stretchable power electronics

Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

- Synthesis, processing, and characterization of high frequency (>100 MHz) magnetic materials with high quality factor (μ_r vs μ_i) as well as high-k dielectric materials with high Q for power components
- Expertise in CMOS power circuit architectures, controls electronics, and MEMS interface electronics
- MEMS packaging / processing for 3D electronics
- Chip-scale energy harvesters with high power densities
- Electromagnetic meta-material development for enhanced wireless power transfer

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