Development of Magnetic Microcalorimeters for Gamma-Ray Spectroscopy
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1. Abstract
We present a progress report on the development of our first complete magnetic microcalorimeter detectors. Transitioning to microdevices with integrated SQUIDs is a promising approach to improve performance. However, new challenges in microfabrication must be overcome, because the underlying SQUID devices are more sensitive to chemical attack and elevated processing temperatures.

2. Integrated SQUID/Sensors with Direct Coupling
- Integrating the SQUID with the sensor in a monolithic thin-film microdevice allows near-elimination of parasitic inductance in flux-transformer-coupled sensors, improving signal/noise
- Integrated SQUID/sensors also offer the possibility to eliminate the flux transformer altogether, further improving signal to noise

3. Heat Flow
- Thermal bus: normal-metal contact out to the ADR

4. Absorbers
- New process: ion-milled copper layer for post definition
- A2125-nKT thick photore sist for absorbers
- Copper improves on SU-8 for post definition
- Pristine strip of SU-8 damages underlying SQUID microdevices and induces mechanical stress in absorbers
- Copper can be stripped rapidly, with high selectivity, and without damaging underlying SQUID microdevices
- Self-aligning: Nb cap is a tight fit around absorber posts, optimizing flux containment and field shaping.

5. Wiring and Insulation
- Underlying SQUID devices are fabricated with a variant of STARcryo’s commercial “Delta 1000” process
- Desirable Modifications to Delta 1000 process:
  - Thicker wiring, for magnetizing currents up to ~100 mA
  - Thinner insulation, improve signal/noise and filling factors
  - A test wafer with 540 nm Nb/80 nm PECVD SiO2/446 nm Nb was fabricated with crossed meander, via string, and capacitor test structures:
    - Chain of 100 4μm diameter vias supports 288mA at 4K
    - 10μm wide Nb traces in base layer support 290mA
    - 10μm wide Nb traces with 624 cousins supports 150mA
    - 1mm x 1mm capacitor structures display no shorts

6. Fabrication
- We have recently fabricated our first-generation of complete magnetic microcalorimeter detectors

7. Particle Testing Setup
- We have developed a basic 50K particle-testing setup and have performed initial checkout using early prototype non-absorber devices with 55Fe source.

8. Summary/Next Steps
- We have completed development of a fabrication process for integrated SQUID/sensor magnetic microcalorimeter detectors with attached electroformed gold absorbers.
- Particle testing of new devices fabricated with this process is expected to begin soon.

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