# NASA TECH BRIEF

*Lewis Research Center*



## MAGNETOMETER USES BISMUTH-SELENIDE

Hall resistivity measurements on single crystals of bismuth-selenide show it to be an excellent material for use as a magnetometer. For any temperature between 300 and 1.2 K (80.33°F and -457.5°F), plots of Hall resistivity versus magnetic field are linear to within the experimental uncertainty of ±1 percent in magnetic fields up to 11 Tesla. The slopes of the plots, however; vary with temperature. In addition, Hall resistivity versus magnetic field plots are independent of temperature to within 2 percent for temperatures below the liquid nitrogen boiling point (78 K) (-319.27°F).

A bismuth-selenide magnetometer has significant advantages over most other magnetometers presently in common use. Being temperature independent below 78 K (-319.27°F), the same calibration can be used for measurements in various cryogenic fluids. Copper magnetoresistors, for example, depend strongly on temperature, thus needing a magnetoresistance calibration for every temperature used. Under variable temperature conditions, this is often impractical. Bismuth-selenide magnetometers withstand thermal cycling from ambient to liquid helium temperatures, as demonstrated by repeated direct immersions in liquid helium with no changes in magnetometer calibrations.

A second significant advantage of the bismuth-selenide magnetometer is the good linearity of output versus magnetic field over a wide range of temperatures. Present Hall effect devices work well at 300 K (80.33°F) but frequently have oscillations superimposed as a function of field at low temperatures. The bismuth-selenide tested was p-type with a carrier concentration of approximately $10^{19}$ per cubic centimeter. Under these conditions, there are apparently no carriers with low enough effective masses to cause oscillatory effects for fields below 11 Tesla.

A third major desirable feature of bismuth-selenide magnetometers is that accurate orientation is possible due to a very flat natural cleavage plane perpendicular to the crystalographic "C" axis.

NOTE:

No additional documentation is available. Specific questions, however, may be directed to:

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PATENT STATUS:

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning non-exclusive or exclusive license for its commercial development should be addressed to:

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