Errors in SQUID measurement

Haohan Wang Department of Physics and Astronomy University of Nebraska-Lincoln **Classical magnetic** materials 3*d* elements and rare earths exhibit magnetic moments of the order of μ_B per atom; thus, even for 1 mg, the magnetic moments of the samples are usually over 10^{-2} emu.

For **thin film**, with a mass lower than 1 μ g so the signal is always of the order of ~10⁻⁶ emu

Investigate signals arising from sample handling or measurement procedures.

A. Kapton tape

Removed cleanly, leaving no residue Exhibits good thermal stability retaining its adherence at very low T Should be a diamagnetic material



(a) M-H curve at300K for KT piecesof different length

(b) the curves aftersubtracting a diamagneticcomponent (normalized tothe piece length)



(c) the curves aftersubtracting a diamagneticcomponent (not normalizedto the piece length)



KT stored in air, the FM signal above 2 μ emu for 60%–70% of the pieces

KT stored in a hermetic plastic bag, the FM signal above 2 μ emu for 10%–20% of the pieces

Dust particles in the air contain typically 3.5% of iron atoms

(d) FM part of the magnetization curve measured at 5 and 300 K.

FM signal observed in KT pieces of the order of 10 μ emu is due to the adhesion of dust particles with iron content.

B. Iron based tools

Many oxides have been claimed to be FM at the nanoscale.

(a) Magnetization curves
from a clean silica glass
3x3x0.5 mm³ before and
after pressing the border
with iron tweezers at 300 K.

(b) Difference between both curves

Avoid using metal tool during magnetic measurement

(c). Magnetization curves ofAl2O3 powder after sievingwith stainless steel andnylon sieves.







C. Gelatin capsules, cotton, and plastic straws





New straw Deformed straw **Straws** m (µemu) may contain magnetic -2 300K impurity -4 -5 -10 5 10 n H (KOe)

Magnetization curve from a piece of 40 mg of commercial cotton at 300 K.

It is always good to do a premeasurement without sample Magnetization curves at 300 K from a Si substrate measured on a nondeformed black circles and a plastically deformed red triangles straw measured with a SQUID.

D. Inks and silver paint

Many commercial inks include magnetic impurities Red and red-based colors often contain iron oxide

magnetic signal is of the order of 1 emu/g of dry silver paint



1.0

Magnetization curve at 300 K from dried silver paint



Conclusion

There are some spurious signals induced by sample handling or measurement procedures that cannot be ignored while measuring thin film.

There are mainly two kinds of spurious signals:

1. Contamination which are proportional to the sample mass.

2. Contamination related to the measurement procedures that introduces a signal irrespective of the sample mass.

It is a good idea to do a measurement without sample to determine the reliability of their magnetic measurements.