VLBA ACQUISITION MEMO #332

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Subject: Magnetic tape surface resistivity variation with relative humidity

Water vapor has a strong effect on head wear (see VLBA Acquisition Memo #s 170 and 286) and is suspected of also having an effect on the generation of deposits which lead to edge damage. The mechanism for the effects of water on head wear is thought to be "static fatigue" (see Bhushan, "Tribology and Mechanics of Magnetic Storage Devices", page 419) involving water-induced bond rupture leading to fracture at the "crack-wall".

Not discussed, is how the water is drawn into the head to tape interface. We suggest that it comes from a surface layer on the tape whose thickness depends on the relative humidity. If the water molecules were drawn into the interface from the air, the head wear rate would depend on the partial pressure of water vapor which is contrary to the observations. (Heating air in the transport lowers the wear rate and RH but leaves the partial pressure of water unchanged.)

We have measured the surface resistivity of magnetic tape (3M) by tightly wrapping a short length around a metal post (oxide in contact with post) and measuring the conductance between the conductive backcoat and the post with a Fluke Model 87 multimeter. For this geometry the conductance for the path across the tape edges is

$$G = (2L/(\tau\rho))$$

where L = length of tape
τ = tape thickness (16 μm)
ρ = surface resistivity (ohms)

The factor of 2 arises from the 2 edges which are connected in parallel.

Figure 1 shows the resistivity for several cycles through a range of relative humidity and two different pieces of tape. These results are similar to those obtained for various substrates (see VLBA Acquisition Memo #327) and are consistent with the formation of layers of water molecules whose thickness is too small to be observed optically. For pure water the volume resistivity is 10^5 ohm-m so that a unimolecular layer of 0.3 nm has a surface resistivity of 3×10^{14} ohms/square. If the surface resistance is from pure water then the measurements of Figure 1 imply a thickness range of 1×10^{-8}m at 50% RH to 1×10^{-6}m at 74% RH. Impurities which increase the conductivity will lower these estimates of thickness.

Figure 1: Log Resistance vs. Relative Humidity for Three 3M Tape Samples