VLBA ACQUISITION MEMO #288

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To: VLBA Data Acquisition Group

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Subject: Progress Report on the Solution to the Tape Edge Heating Problem

Introduction

In July 1991, we started to suspect that the recorders were damaging the thin tape. By mid-august 1991, we were quite certain that we had a serious problem and tentatively identified frictional heating as the cause. Based on a combination of experience and theory (see VLBA Acquisition Memos 266 and 269), we recommended that the running of thin tapes at speed over 160 IPS be avoided whenever possible. We started looking for better edge bearing materials and made some preliminary tests of materials with higher thermal conductivity than the porous alumina coating.

Further Evidence for Edge Damage

Several of the Sony D1K tapes which exhibit packing problems have now been examined under the microscope and clearly show a damaged edge like the melted edges seen in the accelerated wear tests reported in VLBA Acquisition Memo #269. Figure 1 shows an example. Usually the edge damage is on the edge which runs against the precision plate, but there are examples of damage on the edge against the front door. A tape with moderate damage will often wind and pack satisfactorily at low vacuum and high speed. This is consistent with the theory (see VLBA Acquisition Memo #228), that the instability, for a given thickness non-uniformity, can be avoided by decreasing the radial (thickness direction) modulus. Low tension increases the radial compliance. Higher speeds also increase the compliance by air entrapment (see VLBA Acquisition Memos #'s 236 and 263).

Further tests of Edge Bearing Surfaces

Following the tests reported in VLBA Acquisition Memo #274, we continue to look at edge bearing surfaces that have the following desirable characteristics:

a) High thermal conductivity.
b) Low friction.
c) "No stick" (i.e., surfaces to which deposits will not stick).
d) Low wear rate.

Items a) and b) result in a low flash temperature (see VLBA Acquisition Memo #274), while item c) is required in order to maintain a low flash temperature. Item d) is desirable to avoid the need for frequent replacement of the edge bearing surface.

The following table gives the characteristics of the materials which show promise:

Material	Thermal Conductivity W/m/°K	Wear	Comments
Polished Diamond	~1000	None.	Best performance?
Polished Alumina	~40	Very little.	Some deposits stick and build-up.
Copper	~400	Very rapid.	Few deposits stick.
Tungsten	~180	Very little.	Some deposits stick and build-up.
Diamond-like Coating	?	Wears through in a few days.	Few deposits stick.

The diamond "substrate" material is probably[1] the best performer. Some dirt is deposited on the surface but it fails to build into a solid pack. A solid pack of dirt is often the cause of a "melt-down", presumably because the friction is high and the dirt (probably mostly friction polymers) then insulates the tape edge inhibiting the heat conduction path. Copper and tungsten are only considered promising as temporary fixes. At this time, the Mark IIIA processor transports using thin tape have tungsten foil on the precision plate and copper tape on the front door. This "quick-fix" is easy to put on a transport (takes about 15 minutes to install) and doesn't require any special parts. However, it is not yet clear that the tungsten/copper fix affords adequate protection. Figure 2 shows friction polymer deposits on alumina, tungsten and diamond. Note that the deposits on diamond are "incoherent" and generally remain clear of the path of the tape edge.

<u>Proposed Modifications for Permanent Protection Against Edge Damage</u>

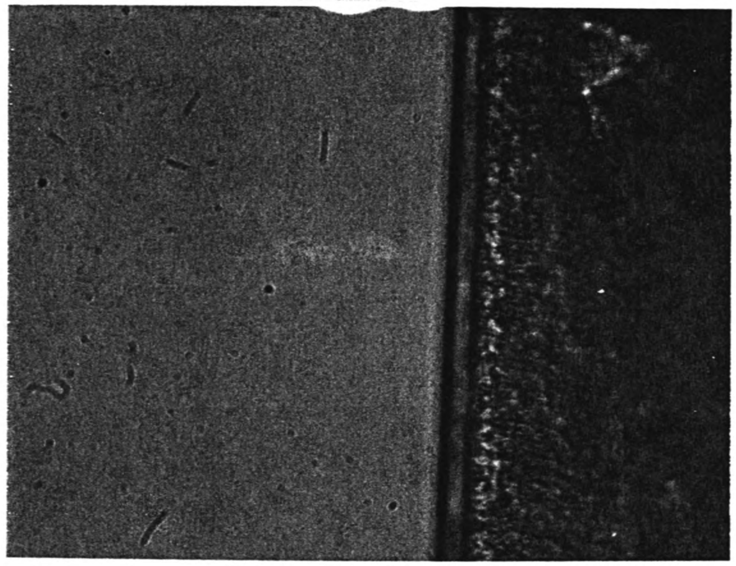
1] Use the new precision plate with provision for hard points. At this time, the polished alumina plates appear to be satisfactory. In the future, sapphire[2], diamond, or other material may be substituted.

2] Replace the front door with new aluminum front door into which hard points have been mounted.

[1]At this time, the pieces of diamond substrate are only 0.5" long and while we have successfully shuttled tape (without damage) on these hardpoints, there is a problem under some conditions. The problem is due to some contact with the sharp edge of the substrate which generates debris.

[2]Sapphire is single crystal alumina. The surface has fewer defects and is not porous so that deposits may be less likely to stick to sapphire. Tests of sapphire are now being made to see if it is significantly better than polished alumina.

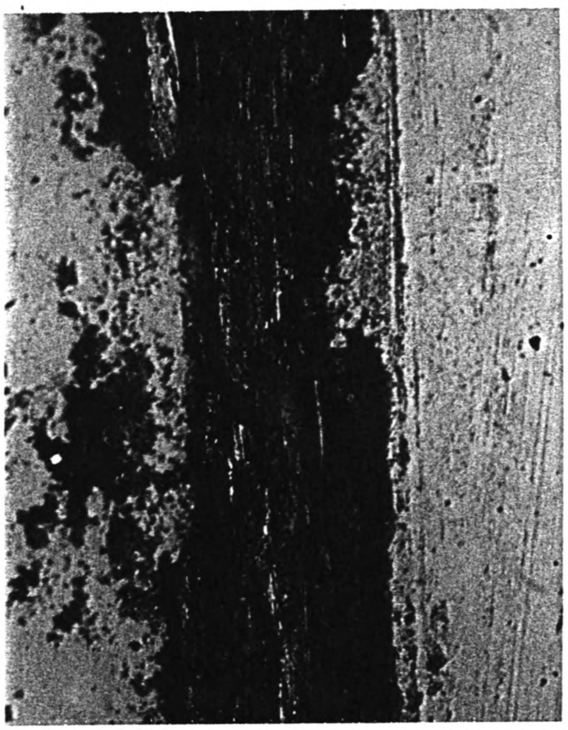
Back-coat Side



X640 SONY D1K USNO1026 - Prec. P.

Figure 1. Sony D1K with severe edge damage on the edge which ran against the precision plate.

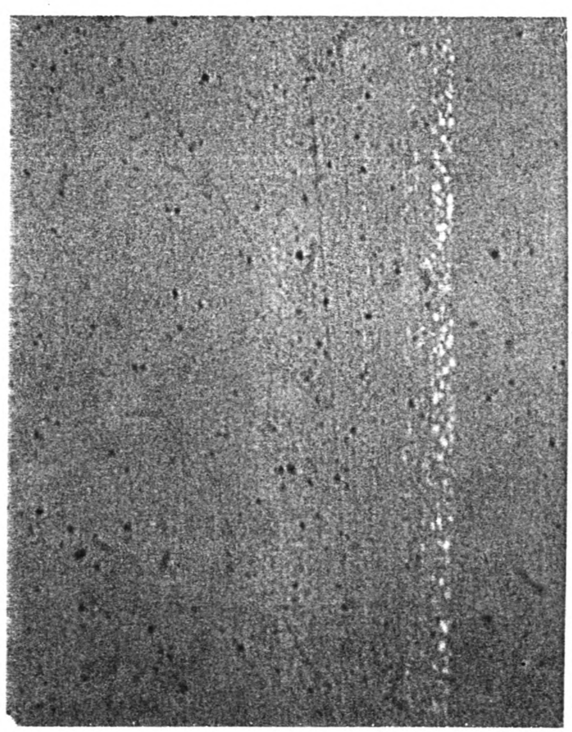
Figure 2. Examples of potentially destructive deposits on alumina(A) and tungsten(B).
Wear marks on alumina(C) after several months of intermittent use.
"Incoherent" deposits on diamond(D).
Deposits and wear on diamond-like coating(E) (approx. 2 microns thick).
Wear scar(F) and deposits on silicon carbide(G).
Deep wear scars on copper(H).



A. X160 Deposit on alumina. X160

B. Tungsten without heat cond. paste.

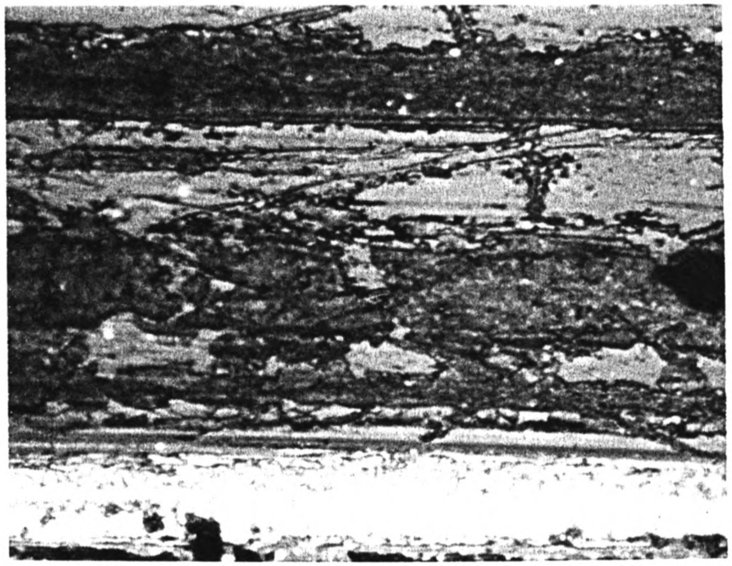
High friction build-up.



C. Wear on alumina used for a few months.

D. X160 "Incoherent" deposits on diamond.

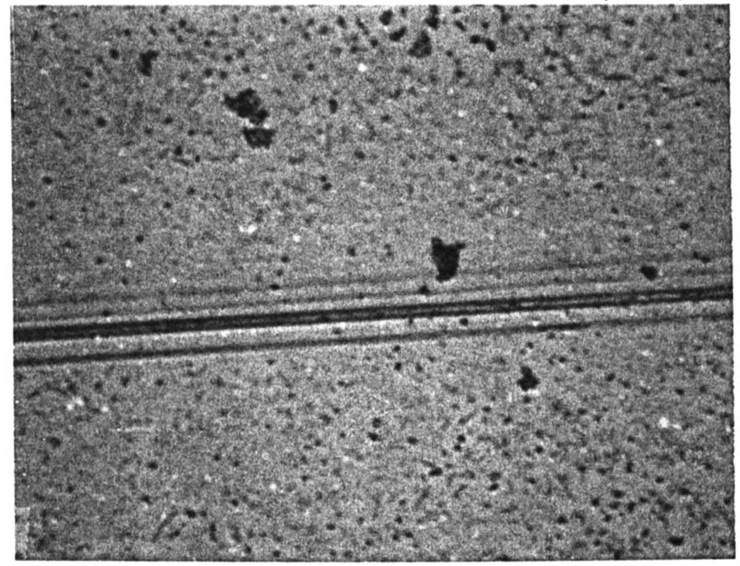
E



E. DLS wear & dirt.

F

6 Sept 91



F. X640 Wear on Silicon carbide.

G

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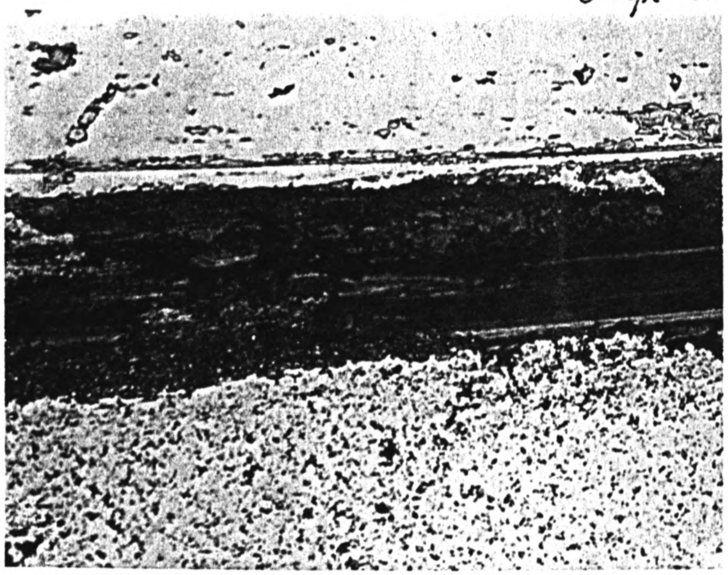
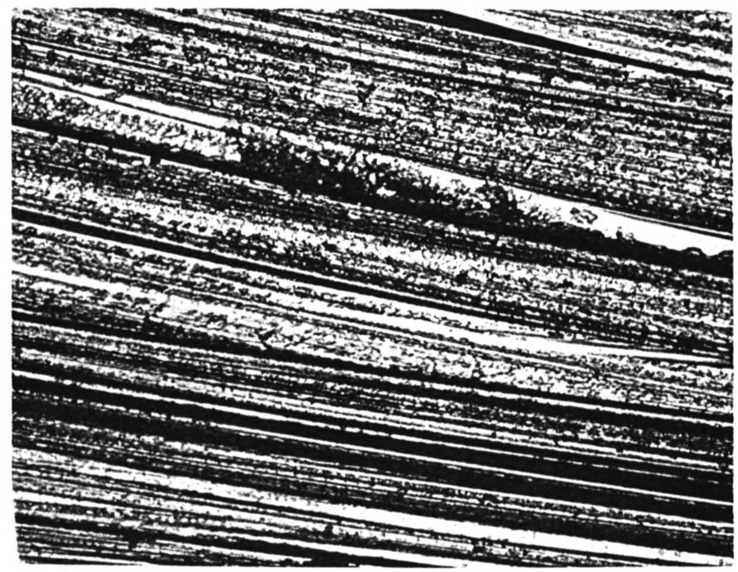


G. X160 Deposits on Silicon Carbide

H



H. X160 5 µm deep wear on copper.

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