Magnetic Tape with Ultra-smooth Low Affinity Surface

Medhat S. Farahat and David E. Nikles

Center for Materials for Information Technology
The University of Alabama

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Lubricant Action on the Tape Surface

The coefficient of friction between a magnetic tape and a guide in a tape path can be minimized by creating **Micro Dimples** between them with a specific geometry. These **Micro Dimples** enhance the formation of air bearings and hence reduce the friction coefficient between the two sliding surfaces due to creation of a minimum spacing between them.

![Surface images](image1)

The concept of **micro formations** made by the lubricant molecules on the tape surface, creates the creation of air bearings between the tape and guide in order to fulfill the optimum spacing and hence the lowest dynamic frictional forces between the two sliding surfaces. The absence of such lubricant **micro formations** on the tape surface results in the complete contact between the two surfaces and hence the dynamic frictional forces reaches its maximum values. Whereas, both little and huge sizes of these lubricant **micro formations** on the tape surfaces lead to the same poor results for the dynamic coefficient of friction, the optimum geometry of these lubricant **micro formations** results in the lowest dynamical frictional forces and hence the lowest dynamic coefficient of friction as in the case of good lubricants.

![SEM images](image2)

The most agreed speculation about the interaction of the magnetic particle MP and the other ingredients in the tape manufacturing recipe is based on the assumption that MR110 (solubilizing polymer) makes the first layer adhered to MP and then comes next the rest of the tape ingredients (binder, lubricant, crosslinker, other additives).

Model Sample Preparation

We started from the idea of considering the MPs forming the core of the structure that is coated with MR110 and then followed by the rest ingredients which are arrayed in a manner according the attraction-repulsion forces between each others.

![Suggested design for the model test sample](image3)

All model samples are prepared according the recipe;

- **Morhane CA-27 (Binder)**: 0.25g
- **Lubricant**: 0.20g
- **Desmodur® L-755 (Crosslinker)**: 0.25g
- **c-Hexanone (Solvent)**: 6.00mL

The homogeneous solution for each sample was spin coated onto a regular microscope glass slide that was pre-coated previously with thin film of MR-110 (2-4µm). After spin coating, all samples were cured by heat ovens at 70-75 °C for 1-2 hours to make sure of complete curing and drying.

![Microscopy graphs for a sample containing starch and lubricant](image4)

![Microscopy graphs for a commercial tape sample (top view)](image5)

The homogeneous solutions for each sample were tested with the **Microtribology tester UMT-2 with stainless steel ball** (9.5mm) suspension mounted on the carriage unit and the test sample mounted on the rotational unit. The most agreed speculation about the interaction of the magnetic particle MP and the other ingredients in the tape manufacturing recipe is based on the assumption that MR110 (solubilizing polymer) makes the first layer adhered to MP and then comes next the rest of the tape ingredients (binder, lubricant, crosslinker, other additives).

![Examples for the studied lubricants](image6)

The endeavor of this work is to seek the highest performance lubricant that shows the lowest possible coefficient of friction as low as (0.05-0.1). This could be achieved by rendering the surface super-hydrophobic with either aliphatic or perfluorinated segments which in turn would result in the desired optimum geometry of the lubricant **micro formations** on the tape surface.

DISCUSSION

We have been struggling for a while, and from various opinions to reach the utmost performance lubricant to attain magnetic tape formulation with ultra-smooth, low affinity surface. The first endeavor was just by rendering the surface hydrophobic/super-hydrophobic and judging the samples according to their contact angle measurements ($\theta$). But, that was not the correct criterion to judge the samples as when we compared the obtained results with those results from coefficient of friction measurements, we found non-consistent results.

From the literature, we found another research group working on Enhancing tribological performance of the magnetic tape/guide interface by laser surface texturing LST. By their technique, they aimed at creating **micro dimples**, with very specific geometry, on the guide surface to create the desired spacing between the two sliding surfaces. They formulated an equation, based on a mathematical model, that predicts the criterion for optimum geometry of these **micro dimples** when the their aspect ratio $\epsilon = \text{height/diameter} \ (\sim 0.01-0.05)$ that would reduce COF to the its minimum value.

The equivalent in function to these **micro dimples** in our work is the lubricant **micro formations** on the magnetic tape surface that fulfill the same task of creating the optimum spacing, once again with a certain specific geometry, between the two sliding surfaces that lead to the lowest dynamical frictional forces. As a conclusion, we can summarize that the target lubricant should be hydrophobic/super-hydrophobic to migrate to the tape surface escaping from the hydrophilic ingredients in the recipe. Also, it should make **micro formations** on the surface with a specific geometry to attain the optimum spacing between the magnetic tape/guide surface and hence the lowest COF according to our recently arrived conclusion.

![Center For Materials For Information Technology](image7)

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