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DETERMINATION OF THE FRICTION OF PAPER AND BOARD

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Colour versions of figures 14 and 15

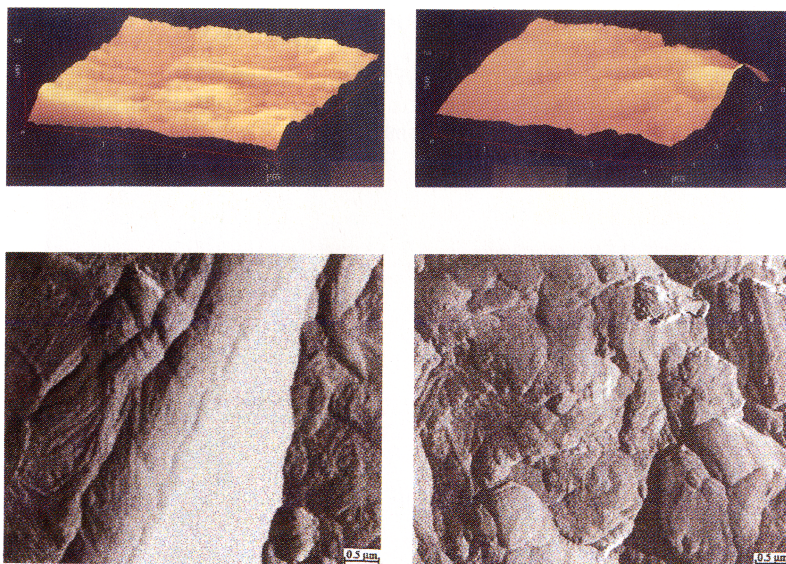


Figure 14 - AFM micrographs of closely located areas, taken before and after sliding contact: (a) showing micro-scale burnishing effects of friction on the areas in contact in the top fibre layer of a well-bonded linerboard sample (L1) after a single sliding contact; (b) showing extensive redistribution and comminution of the mineral filler particles on the surface of a writing paper (WP1) after three sliding contacts.

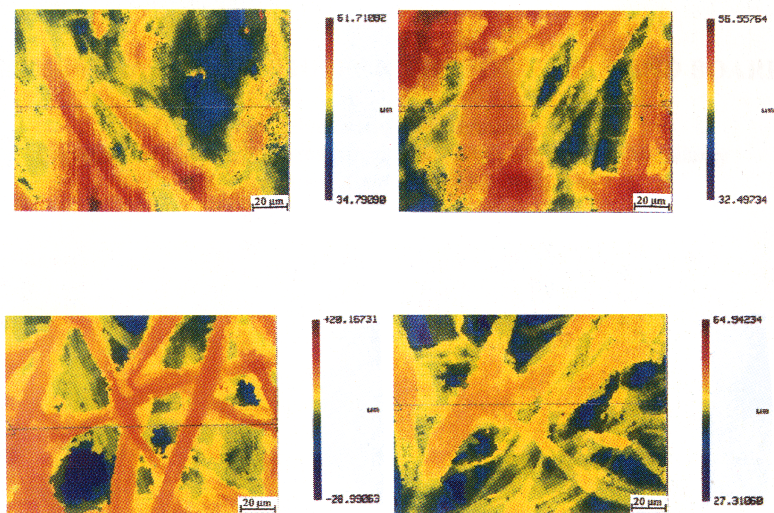


Figure 15 - Non-contact profilometry studies of closely located areas taken before and after three sliding contacts: (a) showing the burnishing and debonding effects of sliding friction on L1; (b) showing disruption of the paper surface and redistribution of the mineral particles on the surface of WP1.

Transcription of Discussion

Determination of the Friction of Paper and Board

Glynis de Silveira, Consultant, Cambridge University, UK

Christer Fellers, Senior Research Scientist, STFI, Sweden

While I agree with most things you have said, I don't agree with what you said about kinetic friction being equal to static if you do sufficiently many slidings. At STFI we have tested tonnes of paper with our friction tester and we don't find that. In some cases this is true but in some it is not. You seemed to propose that this is a general law.

Glynis de Silveira

Yes, I found this to be true with most of the samples tested in the strip-on-drum method. The number of repeated slidings necessary for the static and kinetic frictions to be similar depended on the speed of the sledge in the horizontal-plane method. But in the strip-on-drum method this was consistently so, independent of the rotational speed of the drum. I think that the Coefficient of Friction vs Displacement traces I showed attest to this fact.

Christer Fellers

Is the speed of sliding slow?

Glynis de Silveira

Yes, it was as low as 500 μm per second.

Christer Fellers

Yes, well then I understand the result, and we have found approximately the same results for very low sliding speeds.

Professor Jean-Claude Roux, EFPG, France

Have you tried to do your test measurements with applying the same pressure on the paper samples?

Glynis de Silveira

Yes.

Jean-Claude Roux

And do you find a different co-efficient of friction.

Glynis de Silveira

Yes.

Jean-Claude Roux

Isn't it surprising to get different co-efficients because it's a physical property of both surfaces?

Glynis de Silveira

The coefficient of friction depends partly on the deformation of the paper. When different types of paper were subjected to the same load the amounts of deformation obtained were different. And this may account for the differences in the coefficient of friction. The same was believed to occur when a tensile load was attached to the top paper strip in the strip-on-drum test but in this case the deformation took place along the whole paper strip and not only locally as was the case for the other two tests.

Ilka Kartovaara, R&D Vice President, Enso Group, Finland

You state that the friction co-efficient is composed of two parts, the adhesive and the deformation component. In fact in practically all cases in your experimental results, the friction co-efficient decreases as you increase load. How do you reconcile this with your theoretical aspect?

Glynis de Silveira

These tests were always performed on a set of fresh paper samples. The coefficient of friction results obtained with the inclined and horizontal plane methods seem to be independent of the loads applied. However, when tensile loads were applied in the strip-on-drum method of the coefficient of friction decreased. I believe this results from the

increased deformation of the sheet structure. Hard contaminant particles and/or fillers pigments modified the deformation mechanism of paper and as a consequence the coefficient of friction changed.

Mark T Kortschot, Associate Professor, University of Toronto, Canada

My guess is that friction is rather complicated to measure and when we find material properties like this, often we choose to simulate the end use condition as closely as possible.

Glynis de Silveira

Yes.

Mark Kortschot

Can you give me an idea of how closely the pressures and tensions and so on in the friction tests that you are doing simulate conditions of end use.

Glynis de Silveira

I tried to simulate these parameters taking into account the paper tube making process which was of special interest to this project. I was also trying to simulate the tensile forces to which paper is subjected during some other processes. One of the main conclusions of this work is the need to specify which test method was used and not state only the coefficient of friction value determined. And the test method used should simulate the end-use of that particular paper sample. This is a result of the different values of coefficient of friction determined by the three test methods investigated.