Dr J. Stallard
15/05/13

The comparison of scratch resistance for Solution in Media

Aim

The aim of this testing work is to compare the scratch resistance of four coated and one uncoated glass samples.

Sample reference	Coating
1	Polyurethane protector
2	SiO_2
3	SiO_2 + ND
4	SiO_2 + Graphene ND
5	Non-coated slide

Table 1: coated slides

ST3001 Scratch Testing equipment

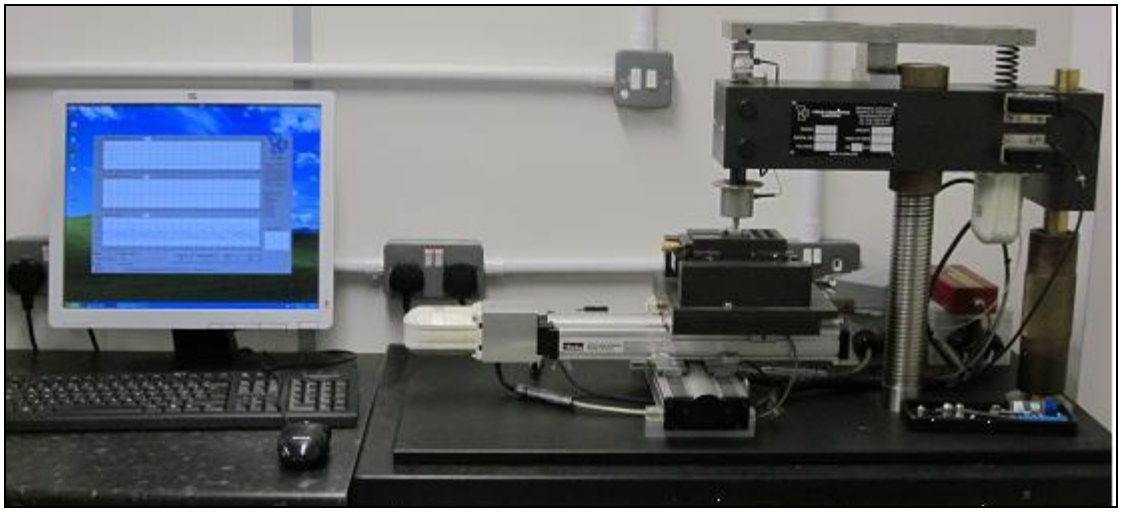

Figure 1: The ST3001 Tribo tester

Scratch adhesion testing is performed on a coated sample to measure the critical load at which a coating shows signs of failure. The test can be performed with varying table speed, load rate, initial load and final load. The friction force and acoustic emission is recorded and displayed during the scratch test. The computer programme includes facilities so that the first derivative of the friction can be plotted to provide a clear indication of the load at which total coating failure occurs.

Test conditions:
0.2mm tip radius Rockwell diamond, 10 to 60N load or maximum friction 30N, 10mm/min. linear velocity, 100N/min. load rate

Test results

A 10 to 60N scratch test was performed on each sample to monitor and compare the friction at increasing loads, see Figures 2 to 6. Sample 1 and sample 5 were noticeably different but it was hard to distinguish between the other coatings.

Test conditions: 0.2mm tip radius Rockwell diamond, 10 to 60N load or maximum friction 30N, 10mm/min. linear velocity, 100N/min. load rate

Sample 1

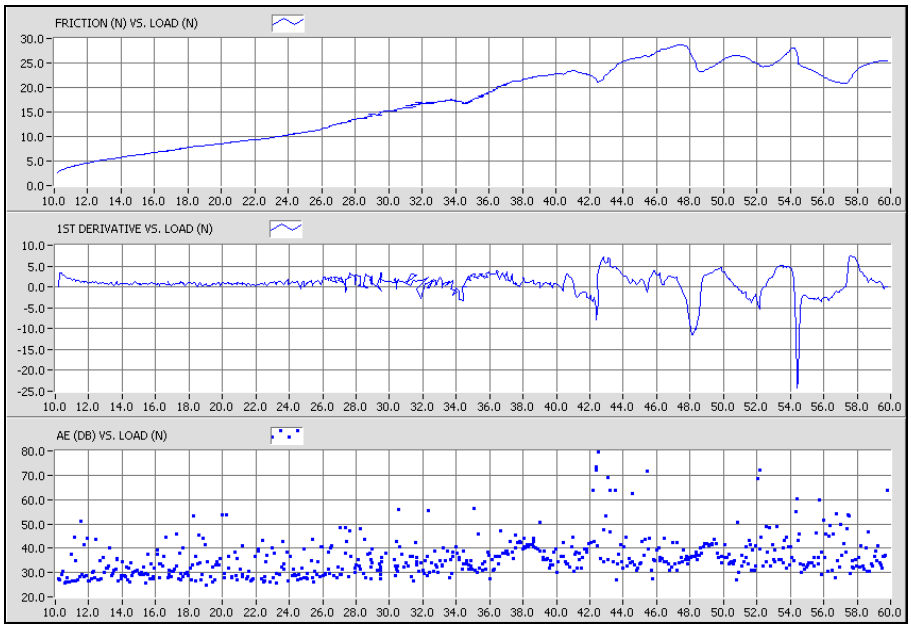

Figure 2: Sample 1 graph of friction vs load

Sample 2

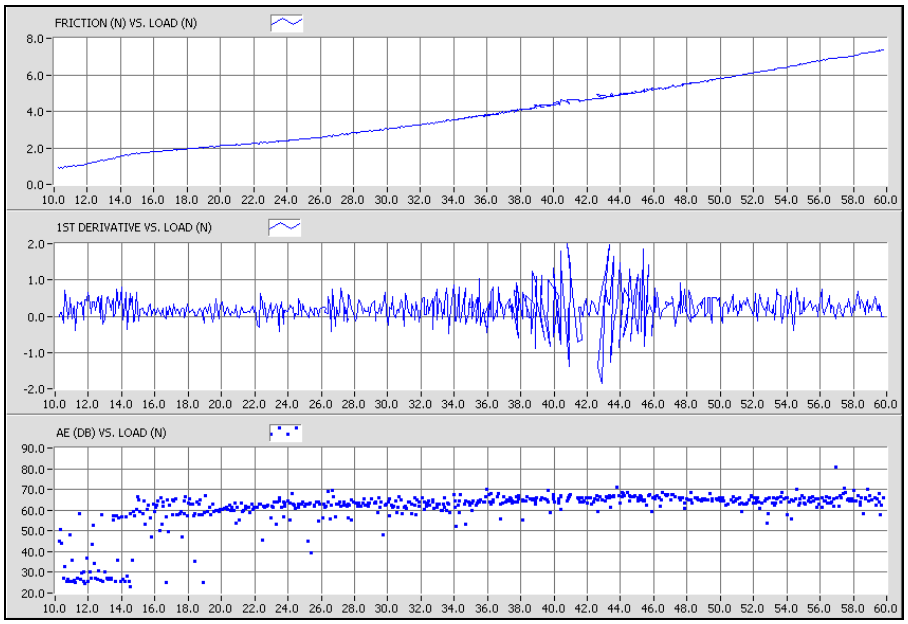

Figure 3: Sample 2 graph of friction vs load

Sample 3

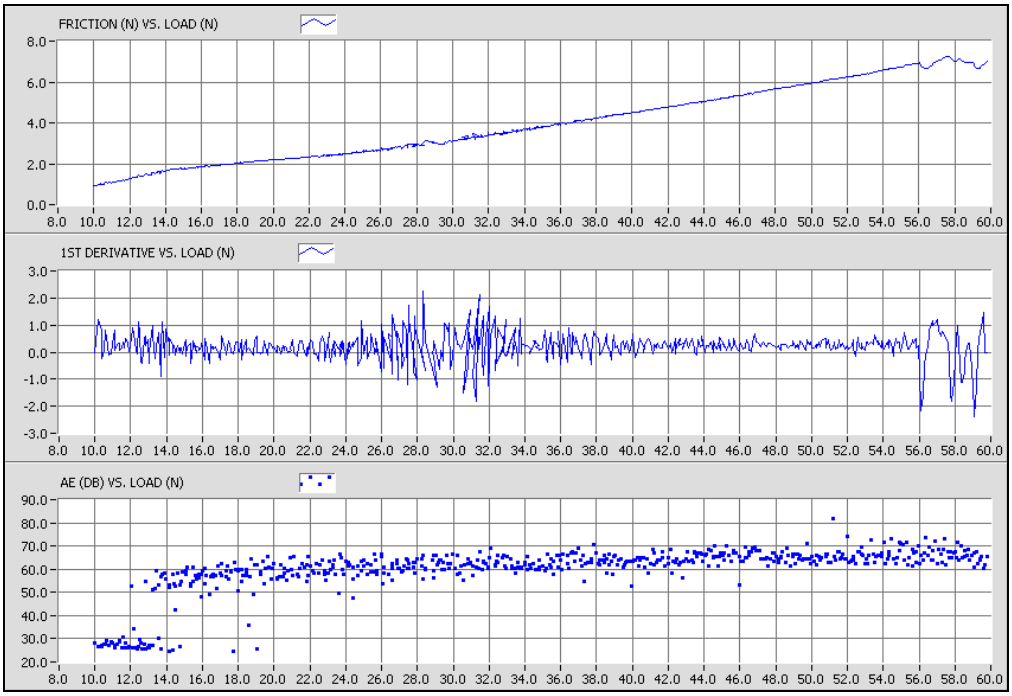

Figure 4: Sample 3 graph of friction vs load

Sample 4

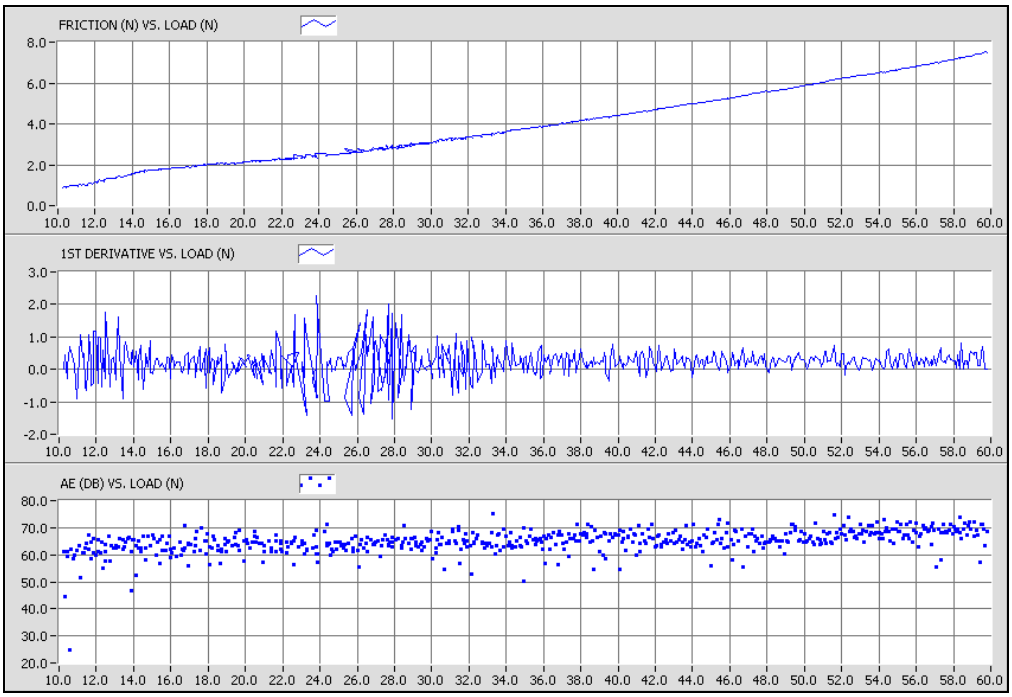

Figure 5: Sample 4 graph of friction vs load

Sample 5

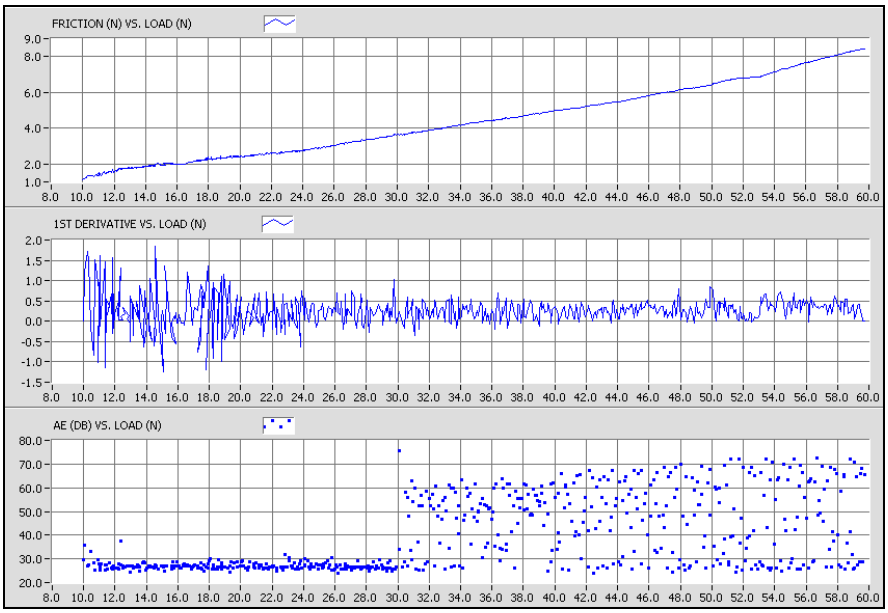

Figure 6: Sample 5 graph of friction vs load

Due to the graphs being difficult to compare, scratches of 5N to 60N were also performed. The data was put into an Excel format so that each graph could directly be compared, Figures 7 and 8.

Test conditions: 0.2mm tip radius Rockwell diamond, 5 to 60N load or maximum friction 30N, 10mm/min. linear velocity, 100N/min. load rate

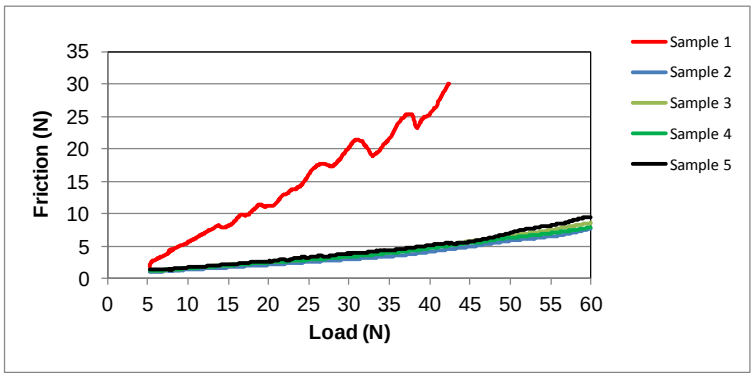

Figure 7: comparison of all scratches

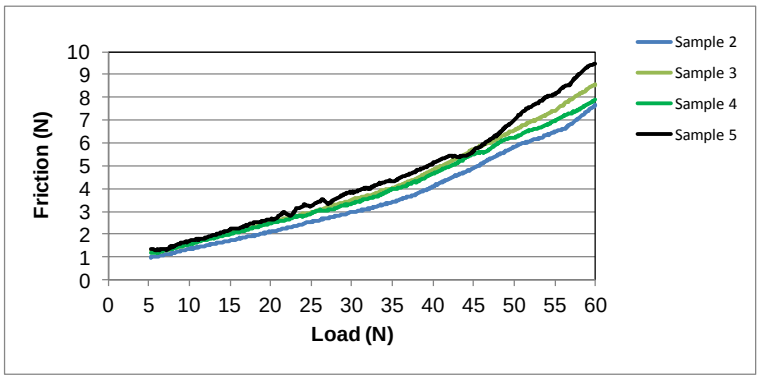

Figure 8: comparison of samples 2 to 5

The graphs (figures 7 & 8) and pictures in Figures 9 to 13 show that the Polyurethane protector performed the worse giving a high friction and very visible damage to the surface (figure 9). Figure 8 shows that when the sample 1 results were removed the four remaining friction graphs were quite similar with samples 2, 3 and 4 just below the friction of that of the uncoated glass slide sample 5. Under the optical microscope samples 2 and 3 looked the most scratch resistant.

1

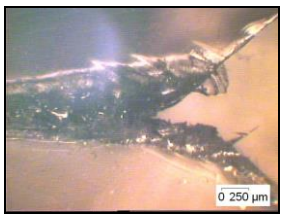

Figure 9

2

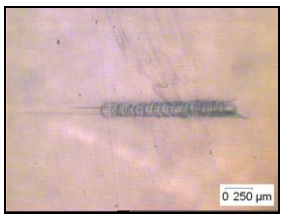

Figure 10

3

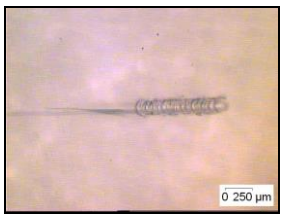

Figure 11

4

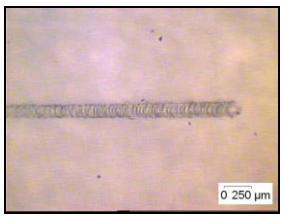

Figure 12

5

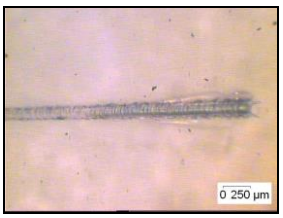

Figure 13

The scratch tests were repeated to see if the results were consistent for each coating and all were compared to the uncoated sample 5.

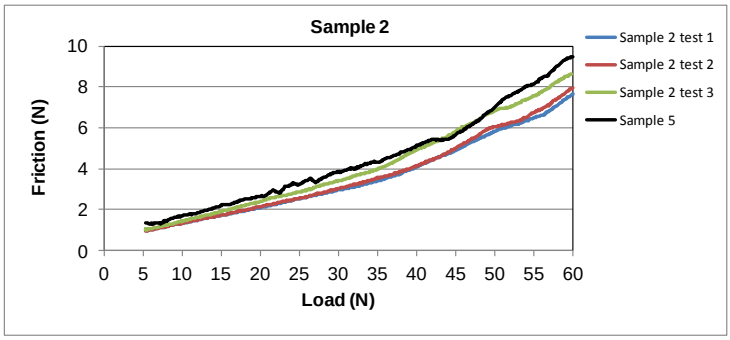

Figure 14: repeated scratches for sample 2

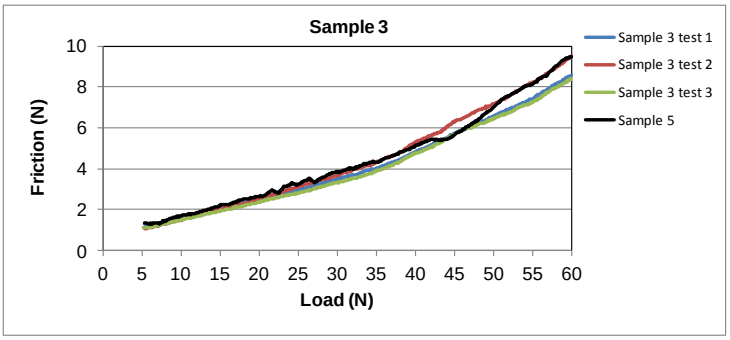

Figure 15: repeated scratches for sample 3

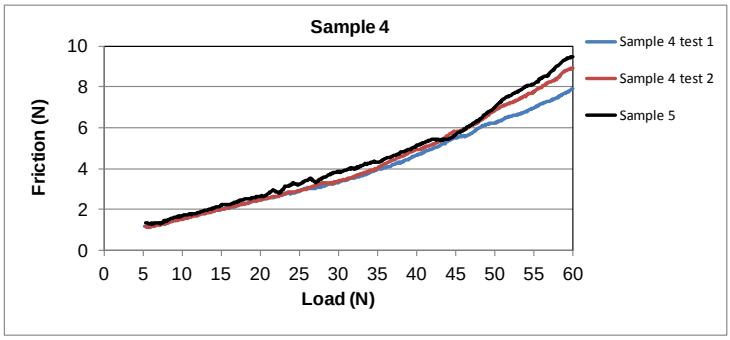

Figure 16: repeated scratches for sample 4

Samples 2, 3 and 4 produced very similar friction results. By eye and under optical inspection samples 2 and 3 look the best as less damage to the surface is visible. Photographs were taken to get a more eye perspective view. The photographs below show clearly that sample 3 was the most scratch resistant followed by 2, 4, 5 then 1 (being the worst).

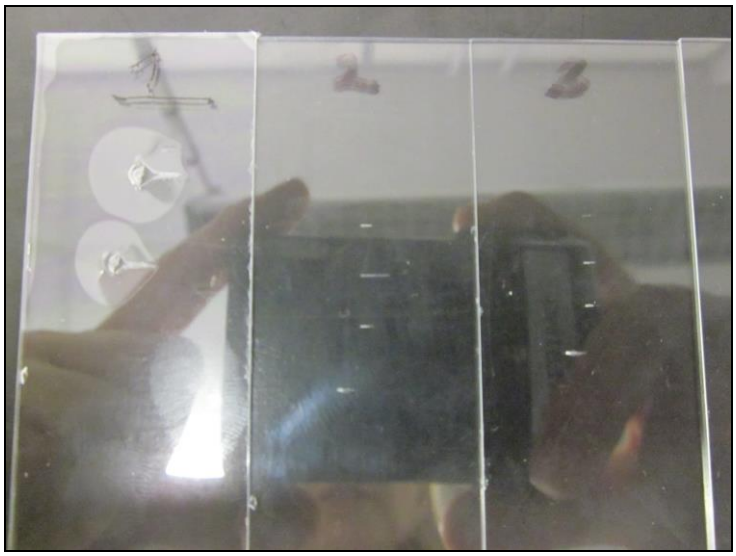
Figure 17: Photographs of sample 1 to 3


Figure 18: Photographs of sample 4 and 5

Scratch measurement results

The scratch tracks from the 10N to 60N load tests were measured under the optical microscope. The results show the applied load at which the sample surface showed signs of cracking. As you can see the measured results do not seem to match up with the graphs suggesting that the friction increase in places was a result of deformation of the sample rather that cracking of the coating. The samples still follow the same pattern of which coating has the best scratch resistance, i.e. sample 2 is 6x more scratch resistant than sample 1 etc.

Sample	Scratch failure (N)
1	10
2	56
3	51
4	17
5	30