Interfacial Adhesion Evaluation of Paint Coatings on a Soda Can Through Scratch Testing

Surface coatings are frequently used to improve the surface properties of the material that they are applied to, also known as the substrate. Such surface property improvements include corrosion resistance, oxidation resistance, thermal barrier, wettability, aesthetics, wear resistance, and scratch resistance. Performing a scratch test on a surface coating can help characterize the mar and scratch resistance, interfacial adhesion strength, and coefficient of friction of such coatings.

One of the most commonly used surface coatings is paint, a two-phase composite material consisting of pigment particles and other additives dispersed in a continuous polymer matrix that adheres to the substrate, protecting it from the surrounding environment. Paint is used in the soft drink industry to increase the aesthetic appeal of the aluminum cans used to store the beverages. It needs to have good cohesive and adhesive strength, as excess scratching or wear during transportation will diminish the aesthetic appeal provided by the paint coating before it reaches its consumer.

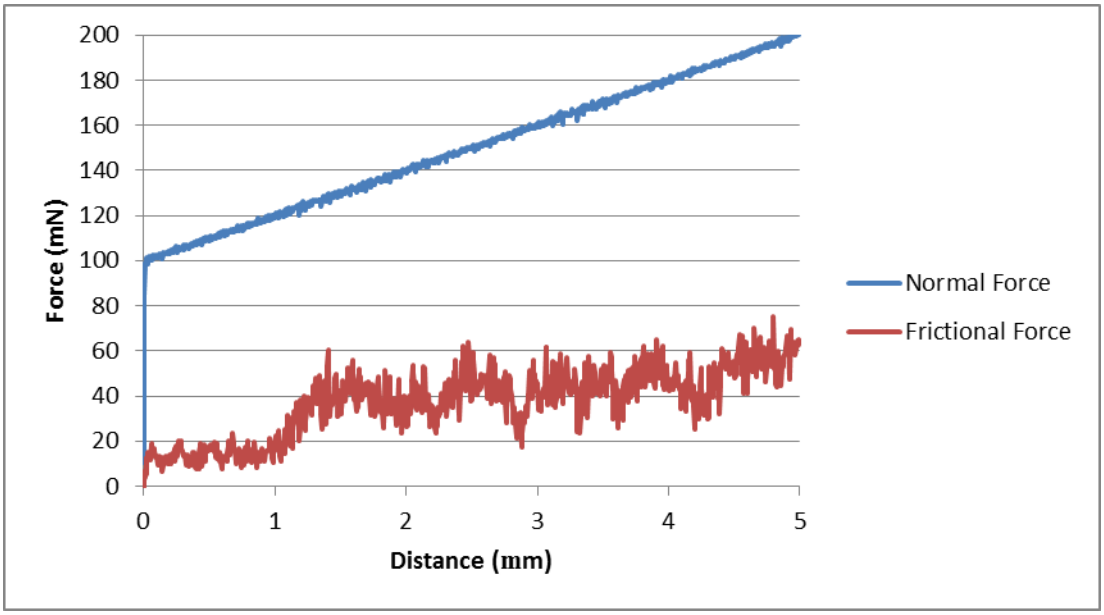

Figure 1. Data from a scratch test performed on the paint coating of an aluminum Soda can.

Scratch testing has been widely accepted and used as a way of evaluating interfacial adhesion of coatings/substrate systems. Failure events may be found where the scratch probe produces delamination, debonding, crack, fracture, or breakthrough at the coating/substrate interface. The failure events of the coatings are normally symbolized by a combination of sudden changes in the lateral force, normal displacement, and/or normal force data. The critical load of coating interfacial failure is defined as the normal force applied to the scratch probe at the time when

interfacial failure is detected. The critical load of coating adhesion failure is a good indication of interfacial adhesion strength. Normally, a higher critical load represents a higher interfacial adhesion. There are a few other ways to help identify critical loads when performing scratch tests. The most common technique involves monitoring acoustic emission from the sample during scratch, which works very well for hard and brittle coatings. Other techniques involve recording and monitoring coefficient of friction, or examining the scratch path with optical microscopy.

Scratch test data for the paint coatings on an aluminum Soda can is shown in Figure 1. This data was obtained on Ebatco NAT Lab's Micro Indentation and Scratch Combi Tester (CSM Instruments, Switzerland).

From Figure 1, it can be seen that there is a large change in frictional force around the 1 mm displacement mark. Figure 2 shows the corresponding location of the scratch as viewed from an optical microscope. The failure location corresponds to a critical load of coating interfacial adhesion failure at 118.88 mN.

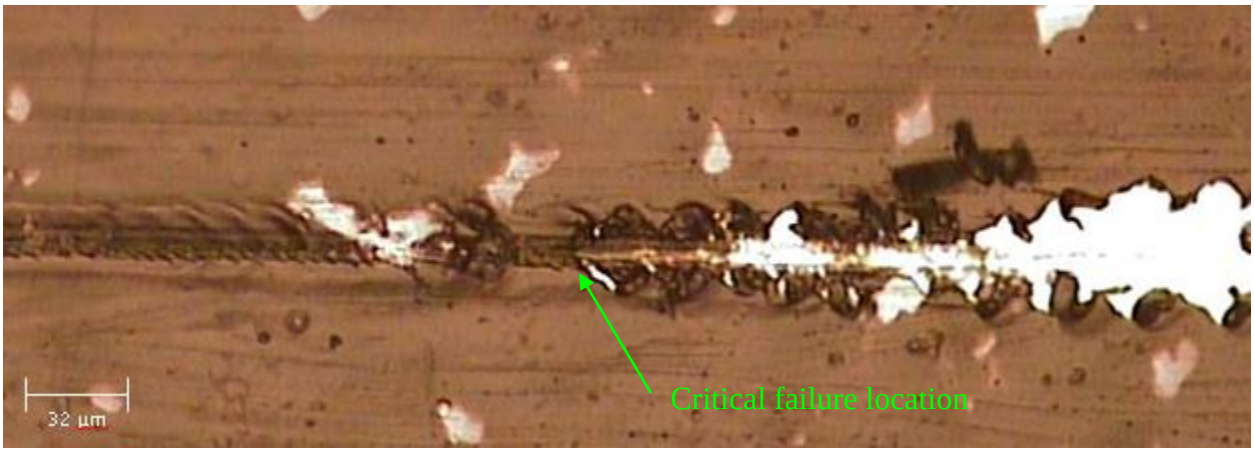

Figure 2. 400x magnified view of critical failure location of the paint coating on a Soda can.