AMP Coating Comparison

Technical Bulletin

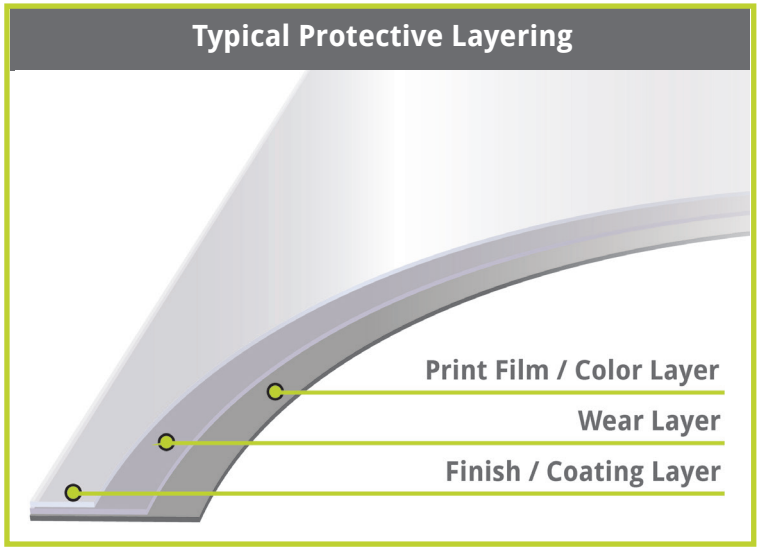
Background

There are several ways to measure the performance characteristics of LVT, WPC and SPC products. Often times, the static load limit, chemical resistance, slip resistance, wear layer thickness and even warranty length are used to determine the durability and suitability of a particular product. However, the most noticeable performance characteristics are often overlooked: the wear, abrasion and scratch resistance of the product.

Though not always quantified and immediately visible, surface wear is one of, if not the, most important performance attributes of LVT, WPC and SPC products, especially in terms of the long-term use of the area. This technical bulletin is intended to analyze the AVA AMP finish and compare its performance with a traditional ceramic-reinforced coating and a leading diamond-reinforced coating.

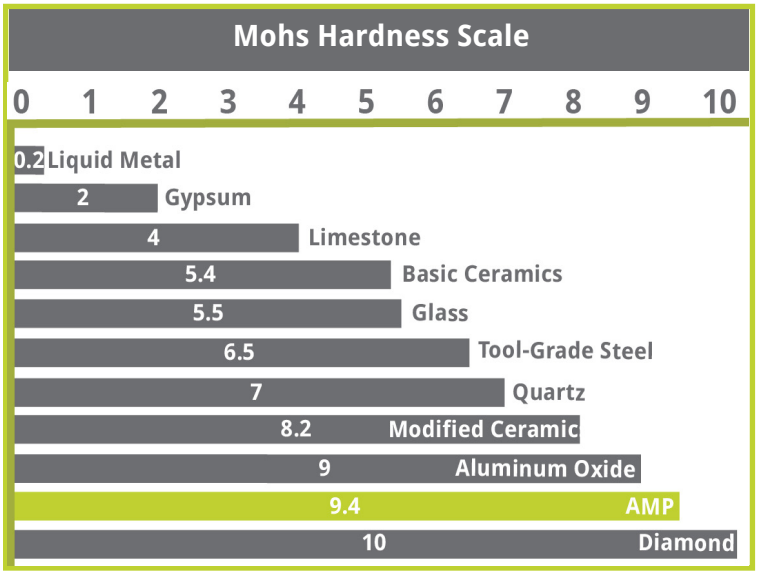
Polyurethane Coating Overview

Most LVT, WPC and SPC products have two layers of protection for the print film or color layer of the flooring material: a clear, laminated virgin vinyl wear layer and a polyurethane coating, which is typically applied during the latter stages of the manufacturing process. Polyurethane coatings are usually reactive and reinforced with hard, fine mineral particles. Once the finish is run through a UV curing machine, the finish solidifies into a tough, durable and protective finish that prevents surface marring and eases maintenance.



Most polyurethane coatings are reinforced with hard and very fine minerals, which are designed to improve the scratch resistance of the finish. However, the scratch resistance of these minerals varies and has a direct impact on the performance of the finish. As the hardness of minerals increases, so too does the inflexibility of the finish - the more inflexible a finish is, the more brittle and prone to cracking it is. This is an important consideration for flexible flooring materials, such as LVT.

The scratch resistance of minerals is measured using the Mohs Scale of Mineral Hardness, which was created by German mineralogist Freidrich Mohs. The Mohs scale runs from 0.2 (liquid metals) to 10 (diamond) and is an ordinal scale, similar to the pH scale. As an ordinal scale, the measurements scale exponentially as the scratch resistance increases. For example, Aluminum Oxide (9) is almost twice as hard as Modified Ceramic (8.2), but Diamond (10) is four times as hard as Aluminum Oxide (9). The most common minerals used to strengthen finishes are Ceramics and Aluminum Oxide.



The proprietary mineral used within the AVA AMP finish has a Mohs rating of 9.4. When comparing AMP to Modified Ceramic (8.2) and Aluminum Oxide (9), it may not seem like a significant difference in scratch resistance. However, since the Mohs scale is ordinal, AMP is over twice as hard as Aluminum Oxide and nearly four times as hard as Modified Ceramics.

Based on the Mohs scale, Diamond-reinforced coatings are a little less than twice as scratch resistant as the AMP coating. In the next section, we'll analyze whether that difference in scratch resistance at the particle level

Comparison Testing Overview

actually results in scratch and wear resistance in practice.

While the scratch resistance of the minerals in urethane coatings is a relevant metric, it is not the best for determining the performance of the finished product. For this reason, we typically perform scratch and wear resistance tests with independent laboratories to confirm and assert the performance of the AMP coating, especially as compared to other polyurethane finish products.

For the purposes of this technical bulletin, we conducted testing on three LVT samples of similar wood grain colors and constructions. Each product had the same wear layer type and thickness (20 mils or 0.5mm), but there were three distinctly different polyurethane coatings on each sample:

- **A Traditional Ceramic-Reinforced Coating**
- **The AMP Coating**
- **A Leading Diamond-Reinforced Coating**

The samples were tested per the following standards to compare the relative performance of each coating:

- **ASTM D4060 -** Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
- **Sim Floor Scratch Resistance Test**
- **DIN EN 16094 -** Laminate Floor Coverings - Test Method for the Determination of Micro-Scratch Resistance.

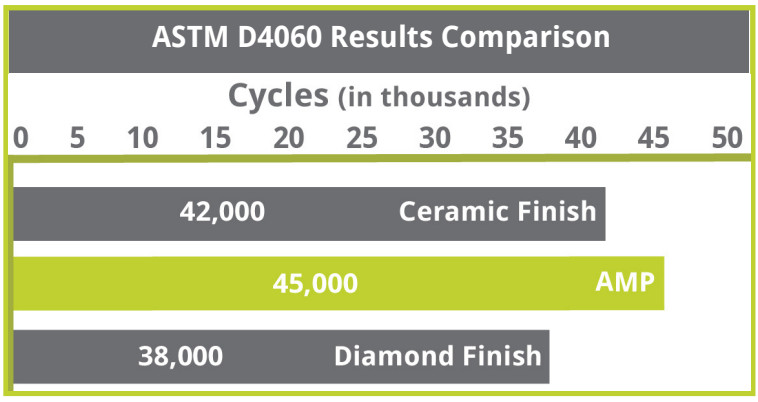
In the following section, we'll review each test method, as well as the comparative results.

Comparison Testing Results

ASTM D4060 - Abrasion Resistance

ASTM D4060 is one of the most common abrasion resistance test methods. It is conducted using a Taber Abraser - a sample is placed on a turntable platform with two counter-balanced wheels that are coated with an abrasive material and set on top. The turntable spins the sample against the abrasive wheels for a specific number of cycles or until the coating and/or wear layer are worn completely through. For the purposes of this technical bulletin, this test was run until wear-through in the print film / color layer was visible.

In the following chart, it's clear that the AMP coating outperformed the ceramic coating - this is to be expected, due to the difference in mineral hardness. However, despite the perceived hardness of diamonds, the AMP coating outperformed the diamond coating as well, lasting 7,000 cycles more, which is 18% longer.



The way the diamond coating wore was also interesting - while it's normal for test samples to indent slightly and have a higher sheen in the wheel path, the diamond coating whitened, deteriorated and built up in the traffic pattern. This could be due to the inflexibility of the diamond mineral in the coating. Regardless, it indicates that there could be other aesthetic issues associated with wear when it comes to diamond-reinforced coatings.

Sim Floor Scratch Resistance Test

The Sim Floor Scratch Test is one of the earliest practical scratch resistance tests ever developed. A Sim Floor wear tester with a 2" head at a 45° angle is fitted with a 3M Scotch Brite pad with aluminum abrasives. The wear tester moves in a linear direction for 200 cycles with 10 PSI of downward pressure, after which the sample is visually observed for gloss / color change and scratching. Ratings are classified according to the following criteria:

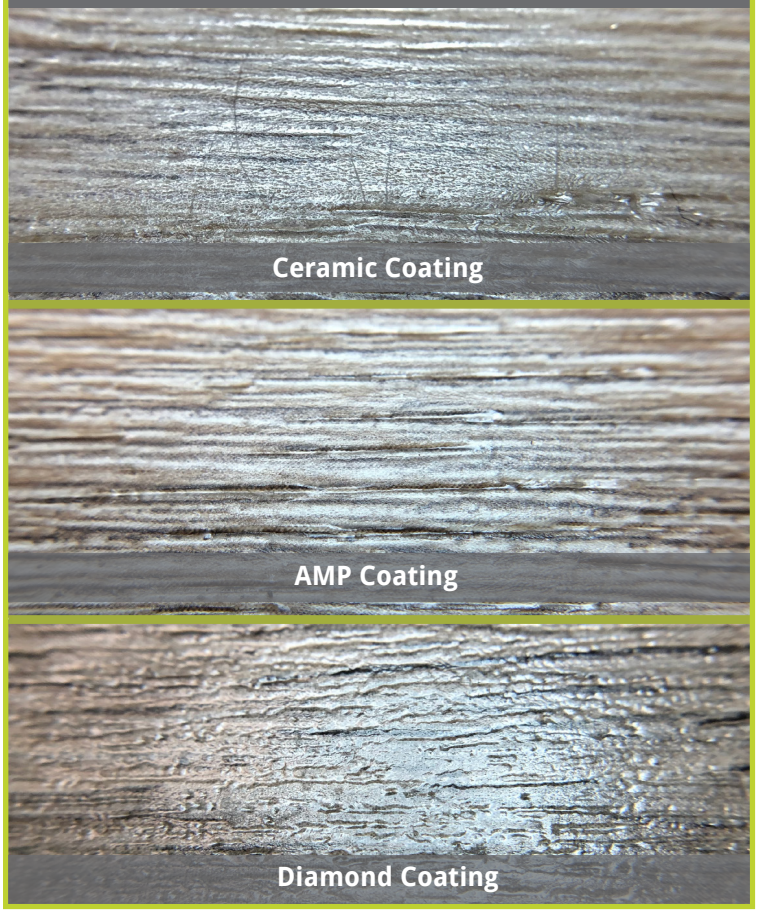
- 5 - No Change
- 4 - Slight Change
- 3 - Noticeable Change
- 2-Considerable Change
- 1 - Severe Change

Based on this criteria, our comparison testing yielded the following results:

Sim Floor Scratch Resistance Results Comparison		
Coating	**Scratch Rating**	**Color/Gloss Change**
Ceramic Coating	3.5	4
AMP	4	4.5
Diamond Coating	4	4.5

Per this table, both the AMP and Diamond coatings showed only slight, unnoticeable scratching and a very slight change in color / gloss level. The ceramic coating, on the other hand, showed slightly noticeable scratches and a slight change in color / gloss change. This confirms that both the AMP coating and the diamond coating offer a noticeable improvement in scratch resistance.

Visible Scratches After Sim Floor Scratch Test



The above photos help illustrate the results of the Sim Floor Scratch Resistance tests. It's easy to see why the Ceramic Coating was rated a 3.5 - scratches are easily visible and there is a noticeable gloss difference where the wear tester made contact with the sample. However, both the AMP Coating and the Diamond Coating showed no visible scratches and only a slight change in appearance.

DIN EN 16094 - Micro-Scratch Resistance

DIN EN 16094 is a European test method that improves on the original Sim Floor Scratch Resistance test. EN 16094 is intended to measure scratch resistance, but particularly focuses on micro-scratches that are commonly caused by the movement of furniture or equipment and commercial foot traffic. EN 16094 is conducted using a Martindale Tester - a sample is clamped to an abrading table, then a reciprocating head with a weighted 3M Scotch Brite pad attached is placed on top. The reciprocating head moves the Scotch Brite pad in a random pattern in order to create micro scratches on the surface of the sample.

EN 16094 Classification Criteria			
Procedure A - Gloss Rating		**Procedure B - Scratch Rating**	
MSR Rating	**Change in Gloss**	**MSR Rating**	**Scratch Level**
MSR-A1	≤ 10%	MSR-B1	No Scratches
MSR-A2	> 10% - ≤30%	MSR-B2	Few Scratches
MSR-A3	> 30% - ≤50%	MSR-B3	Many Scratches
MSR-A4	> 50% - ≤70%	MSR-B4	Many Scratches, Raw, Fine and Visible
MSR-A5	> 70%	MSR-B5	Extreme Scratches, Machine Pattern Visible, Mat Abrasion in Center

There are two methods for classifying micro-scratches under this test method: procedure A is meant to classify the micro-scratch resistance (MSR) based on gloss change after 80 cycles, while procedure B is meant to classify the micro-scratch resistance based on a visual assessment of scratches after 160 cycles.

Concluding the test, the change in gloss level and amount of scratches are classified by a panel of three technicians, according to EN 16094 Classification Criteria chart. Based on this criteria, our comparison testing yielded the following results:

EN 16094 Results Comparison		
Coating	**MSR-A Rating**	**MSR-B Rating**
Ceramic Coating	MSR-A4	MSR-B2
AMP	MSR-A1	MSR-B2
Diamond Coating	MSR-A1	MSR-B1

Per the previous table, the AMP coating showed no change in gloss and only a few scratches following the test - this is in contrast to the ceramic coating, which showed a significant change in gloss. This would likely lead to the appearance of traffic patterns, as the change in sheen would be clearly visible. The diamond coating, on the other hand, showed no visible scratches or change in sheen, highlighting the scratch resistance of the diamond mineral additive. It slightly outperformed the other coatings tested.

Summary

As evidenced in this technical bulletin, there are several performance advantages to the AMP coating, especially when compared to traditional ceramic-reinforced coatings that have been in use for decades. Not only does AMP last longer in terms of wear, but it is also less likely to scratch and show the appearance of scratches during normal use. This exhibits both our commitment to improving the durability and longevity of our products and the necessity of doing so.

Perhaps more importantly, this technical bulletin also shows that the AMP coating performs as well as diamond-reinforced coatings when it comes to scratch resistance and outperforms diamond-reinforced coatings when it comes to wear and abrasion resistance. The diamond coating showed more severe visual wear in a much shorter period of time than the AMP coating. Though diamond particles are technically harder than the mineral used in AMP, the inflexibility of these particles could be contributing to the reduction in wear and abrasion resistance.

For additional information, please consult the associated technical information or contact AVA technical services: 1.800.861.5292 - support@avaflor.com