CeramicSteel

PRODUCT SPECIFICATIONS PROPERTIES EXPLAINED

A reference guide to understanding specifications

PolyVision®
a steelcase company

HOW TO UTILIZE THIS DOCUMENT

The goal of this document is to clarify the technical properties of PolyVision's surfaces as given in the product specifications. With this document, we aim to provide objective and relevant information to whom it may concern about these properties using brief test descriptions and why they are important to our customers.

1. Total thickness enamel top coatings | ISO 2178 / ASTM B499

3. Thickness back-side enamel coating | ISO 2178 / ASTM B499

Test description: The measurements are performed using a digital coating thickness gauge that uses the principle of electromagnetic induction. Since the steel core of e³™ CeramicSteel is magnetic, the thickness(es) of coating(s) influence, proportional to the layer thickness, the electromagnetic field generated when the measuring probe is placed onto the surface.

Reference norm/specification or document: ISO 2178 / ASTM B499

In practice: The layer thickness(es) not only contribute to the total thickness of the e³ CeramicSteel but also determines the color, coverage and texture of the cover coat. A constant inline thickness control guarantees a consistent color and texture, which is important when making installations with multiple boards. Because the total layer thicknesses are only about 100 µm or 0.1 mm total on the topside, e³ CeramicSteel can be bent without forming microscopic hairlines or cracks, with a minimum diameter of 300 mm. This is because just like glass fiber, which is also flexible, the very thin layer thicknesses give the e³ CeramicSteel its flexibility. This also allows e³ CeramicSteel to be recoiled during production onto cardboard tubes of 300 mm diameter, in units of 120 to 150 running meters.

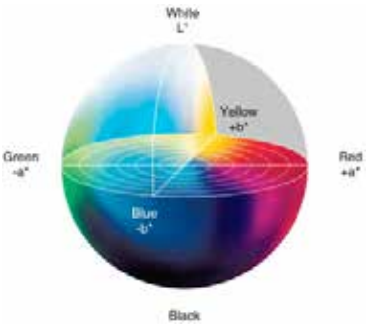
2. Steel thickness

4. Total thickness

Test description: Steel thickness and total thickness are measured using a micrometer gauge, for example, during incoming inspection of the bare steel coils.

Reference norm/specification or document: NA

In practice: The steel thickness is important since it determines the total thickness of e³ CeramicSteel, which needs to stay within given tolerances to guarantee the appropriate fit into the final panel or board assembly. The steel determines the weight of e³ CeramicSteel. Steel thickness is also a major factor in the flexibility of the e³ CeramicSteel contributing to its ability to be recoiled.

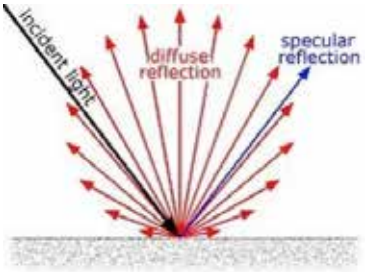


8. Color deviation from standard | ISO 7724 / ASTM D2244-02

Test description: Color measurement is performed while e³ CeramicSteel is manufactured. During production, the color is measured and compared against the zero standard of PolyVision standard colors (or the customer-approved custom developed color sample). The measurement involves a handheld spectrophotometer that illuminates the sample to be measured using a standardized light source, and then analyzes the reflected light spectrum and expresses it in L* (light-dark), a* (green-red) and b* (blue-yellow) values. These three make up a point in the three-dimensional L*a*b* space. The color difference ΔE^{94} is defined as the vectorial distance between the zero standard and the actual e³ CeramicSteel material in production, and must remain within specification.

Reference norm/specification or document: ISO 7724 / ASTM D2244-02

In practice: Color consistency is very important, for example. When e³ CeramicSteel is used in winged boards or adjacent panels where color consistency is required. In addition, when panels need to be replaced for whatever reason, the color consistency must be guaranteed over time. This is why the color difference is specified in ΔE^{94}. When color differences are measured using this standard, there is a better correlation with the sensitivity of the human eye to colors. For example, the human eye can see even small color differences in whites but is much less sensitive to reds.

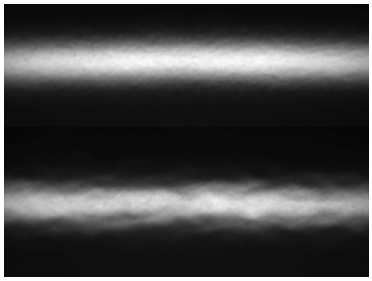


9. Gloss | ISO 2813 / ASTM D523 60°/20°

Test description: Gloss level is monitored online using a handheld gloss meter. It contains 1, 2 or 3 light sources such that the incident light is at 20°, 60° or 85° from the normal. Light receptors at the opposite angles -20°, -60° and -85° measure the amount of light that has been reflected by the sample, which is a measure of the specular gloss of the surface. The angle chosen for measurement is determined by the surface itself, to obtain significant readings.

Reference norm/specification or document: ISO 2813 / ASTM D523 60°/20°

In practice: The gloss level of a surface determines the way it reflects light coming from projectors, ambient light or natural light and lighting fixtures. Since these reflections might be experienced as disturbing, PolyVision offers a range of gloss levels that can be suited to the meeting room or classroom configuration.



10. Waviness (“orange peel”) Byk-Gardner Wave Scan 5+: Wd (3-10 mm) | PVNV 41.822

Test procedure: Waviness is a measurement to determine surface texture. The Byk-Gardner Wave Scan 5+ is a handheld device dragged over the surface to be tested while a laser beam scans the surface texture. The number at texture magnitude of 3 to 10 mm (interval Wd) proved to be the most significant for differentiating between different surface textures.

Reference norm/specification or document: PVNV 41.822

In practice: Sprayed coatings are applied using pressurized air nozzles, which break the liquid coating into tiny droplets. Depending on the viscosity and flow behavior of the coating, this pressurized air creates a ripple in the applied coating, creating a typical surface texture also known as “orange peel” (see bottom on the right-hand picture). When viewing such a surface in reflected light, the observer sees this texture as light-dark effects caused by the hills and valleys in the surface, which can be disturbing. A non-sprayed surface (see top on the right-hand picture) does not show orange peel and thus exhibits a much smoother visual aspect.

Very mat surfaces like PolyVision’s chalkboard material hardly read any texture at all using this test (Wd Max 0.5), which means that, visually, chalkboard material will show no surface texture. Whiteboard surfaces that have higher gloss levels show higher readings, which are limited to avoid showing disturbing orange peel (Wd Max 10 for e³ L and e³ S and Wd Max 20 for e³ H and e³ U).

11. Mohs surface hardness | EN 15771

Test procedure: The Mohs hardness test consists of a series of 10 different minerals with increasing hardness. The softest mineral (talc) is 1 on the Mohs hardness scale, whereas diamond is 10. Each mineral is dragged over the surface to be tested, and the lowest mineral that does not cause the surface to be scratched is noted as the Mohs hardness of the sample.

Reference norm/specification or document: EN 15771

In practice: Since e³ CeramicSteel reads a minimum of 5 on the Mohs hardness scale, it is harder than apatite (Mohs 5) but will be scratched by feldspar (Mohs 6). In practice, this means that when a copper coin is dragged over the surface, one would not be able to scratch it and thus permanently damage the e³ CeramicSteel. In fact, it is likely copper would be abraded off the coin onto the surface since e³ CeramicSteel is harder.

12. Scratch resistance | ISO 15695

Test description: The scratch resistance test consists of a turning table onto which the sample to be tested is clamped and a weight-loaded arm that drags a standardized diamond needle over the surface as the sample turns one revolution. The weight load can be varied between 1 Newton (100 g force) and 10 N (1 kg force). Thus, 10 concentric scratches are made for each load. Then, the scratches are incolorated using drymarkers in four colors. After drying the ink and wiping clean the sample, one evaluates visually which of the 10 scratches has permanently damaged the surface, such that ink stays within the scratch after dry erasing.

Reference norm/specification or document: ISO 15695

In practice: The needle used in this test is made of diamond, which is the hardest material on Earth. Therefore, by definition, it will scratch anything, even e³ CeramicSteel, although it is glass hard. The scratches on e³ CeramicSteel as a result of this test however, are very shallow so the surface is not damaged to the extent that drymarker ink will remain. In practice, this means that even with a very high point load (such as keys or ballpoint pens), even using material harder than e³ CeramicSteel, it is nearly impossible to permanently damage the surface, such that incolorated scratches require the board be replaced.

Typically, porcelain enamel boards such as e³ CeramicSteel show a minimum of 7 N for this test, whereas other materials result in only 1 to 3 N.

13. Pencil hardness | ASTM D-3363 / EN-ISO 15184

Test description: This test consists of a series of pencils with increasing hardness ranging from 6B (softest) to 9H (hardest), to be dragged over the surface at a given angle and weight load. The hardest pencil that does not scratch, and thus permanently damage the surface, is noted as the pencil hardness.

Reference norm/specification or document: ASTM D-3363 / EN-ISO 15184

In practice: This test is typically used for organic coatings, such as lacquered steel. Porcelain (vitreous) enamel will not be scratched by any of these pencils because it is far harder than whatever pencil is used.

14. Wear resistance | ASTM C 501 (Abrasive S 33/1 kg/1000 revs.)

Test description: The Taber abrasion test consists of a sample mounted onto a turning table while two weight-loaded abrasive wheels abrade the surface as the sample is made to do 1000 revolutions. The abrasive wheels consist of rubber onto which a standardized strip of abrasive paper (S33) is taped. Each wheel is loaded with a weight of 1000 g (1 kg). This will cause the surface to be abraded and thus lose some of its original weight. The recorded weight loss is a measure of the sample's wear resistance and durability.

Reference norm/specification or document: ASTM C 501

In practice: This is a severe test, since even e³ CeramicSteel is abraded such that the surface loses its gloss. However, e³ CeramicSteel will lose a maximum of only 0.1 g of its original weight, whereas other material such as melamine (formica) loses more than a full 1 g of its weight. Most organic surfaces even show their coating as perforated down to the substrate (see pictures).

15. Impact resistance | ISO 4532 (< 2 mm)

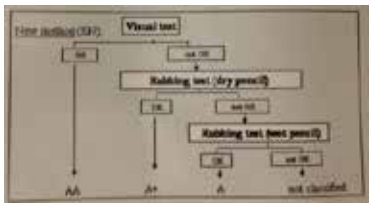
Test description: The impact test consists of a device (the Wegner pistol) that contains a spring-loaded steel ball, which is shot onto the surface to be tested with a force of 20 N or 2 kg force.

Reference norm/specification or document: ISO 4532

In practice: e³ CeramicSteel shows high wear and scratch resistance because of the glass-hard porcelain (vitreous) enamel coatings. Similiar to glass and most hard materials, this inherently means a certain brittleness. A high force impact destructive test such as this impact test therefore damages the surface permanently, which is why international quality standards limit the dimension of the impact damage in this test. As a result the surface will crack showing small circular damage that may not be larger than 2 mm in diameter after 24 hours at room temperature. Many factors influence the outcome of the test, such as the substrate onto which the e³ CeramicSteel is laminated.

16. Cold acid resistance | EN 14483-1-9 / ISO 28706-1-9

Test description: This chemical resistance test consists of exposing the surface of e³ CeramicSteel to a 10% solution of citric acid at room temperature for 15 minutes. To avoid evaporation, the acid solution is capped with a watch-glass. After the exposure, the sample is rinsed, cleaned, dried and visually ranged into the classes defined in the standard. For example, a rating of class AA means no visual change in the color nor gloss of the surface. A rating of class A+ means there is some visual change, but dry cleaning pencil markings off the tested surface versus the untreated part is not more difficult.



Reference norm/specification or document: ISO 28706-1-9 / EN 14483-1-9

In practice: When cleaning a board or panel surface, many domestic cleaning agents are used. Many contain citric acid for degreasing purposes. In such a case, the e³ CeramicSteel surface is not affected by the cleaning agent, so that the color, gloss and functional properties such as erasability are maintained. This ensures that whatever cleanser is used, the surface remains unaffected.

17. Solvent test: toluene, methylethylketone, ethylalcohol, petroleum, grease, oil, ethylacetate or xylene (Dip 25 °C, 1.000 hours) | PVNV 41.822

Test description: This test consists of submerging the sample to be tested into the following solvents: toluene, methylethylketone, ethylalcohol, petroleum, grease, oil, ethylacetate or xylene. The test is performed at room temperature for 1000 hours (6 weeks) after which the sample is visually evaluated for changes in the surface.

Reference norm/specification or document: PVNV 41.822

In practice: e³ CeramicSteel consists of a steel core and glassy, inorganic porcelain (vitreous) enamel coatings. Inherently these are impervious to any organic solvent, no matter how long the surface is exposed to them. Many organic coatings like lacquered steel do not resist these strong solvents. When, for example, e³ CeramicSteel is written on by permanent markers or even graffiti, this test shows that those can be removed using any suitable solvent without having to fear for any surface deterioration.

Class	Test method(s)	Classification criteria
A1	EN ISO 1182 *	$\Delta T \leq 50$ °C; and
	and	$\Delta m \leq 50$ %; and
		$t_f = 0$ (i.e. no sustained flaming)
	EN ISO 1716	PCS $\leq$ 2.0 MJ/kg * and
		PCS $\leq$ 2.0 MJ/kg ** and
		PCS $\leq$ 1.4 MJ/m² * and
		PCS $\leq$ 2.0 MJ/kg *

18. Fire resistance | EN 13501-1 +A1

Test description: This norm classifies products using data from reaction to two fire tests. To obtain the highest fire classification (A1) according to this norm, e³ CeramicSteel will be subjected to two standardized fire tests: (EN) ISO 1182 (Non-combustibility test) and (EN) ISO 1716 (Determination of the heat of combustion).

The non-combustibility test determines whether a material will catch fire while the determination of the heat of combustion test measures how much heat the material will generate should it catch fire (see below).

Reference norm/specification or document: EN 13501-1 +A1: references to (EN) ISO 1182 (Non-combustibility test) and (EN) ISO 1716 (Determination of the heat of combustion).

In practice: PolyVision's e³ CeramicSteel is classified as incombustible and scores the best fire behavior rating (A1). In practice, this means that in the event of a fire e³ CeramicSteel will not catch fire generating additional heat or sustained flaming. When e³ CeramicSteel is laminated onto a substrate board, such as particle board, the fire resistance classification of the board mainly depends on the fire resistance classification of the substrate.

19. Color stability | ASTM C 538

Test description: This test consists of exposing the sample to be tested to a saturated solution of cupric sulfate while exposed to a standardized source of ultraviolet light for 24 hours at room temperature. Cupric sulfate serves as a catalyst to promote color change by UV light of non-UV-resistant colorants. After the test, the sample is cleaned and dried, and the color difference between the cupric sulfate exposed and non-exposed part of the sample is measured.

Reference norm/specification or document: ASTM C 538

In practice: e³ CeramicSteel visual communication surfaces contain only UV-resistant colorants, so no color change occurs during this test. This is because the raw materials, and especially the colorants, are all oxides of metals (for example, black and brown are mostly iron oxides). Since these color oxides are already oxidized, they cannot be oxidized further under the influence of UV light and therefore will not change in color after being exposed to UV through windows or when exposed in open air. Organic colorants such as used in paints and lacquered materials often are not UV resistant and are not used.

20. Writeability of chalk | PVNV 41.810

21. Dry erasability of chalk | PVNV 41.811

Test description: To evaluate if e³ CeramicSteel chalkboard surface has sufficient bite to retain sufficient chalk while being written upon, this test consists of dragging a standardized piece of chalk over the chalkboard surface loaded with a 775 g weight. Using color measurement, the color difference ΔE^{94} is measured as a measure of the amount of chalk on the surface. The higher the ΔE^{94}, the better the writeability of chalk.

Next, the dry erasability of chalk is tested by erasing the chalk using a latex eraser, which is also weight loaded at 760 g. Again, the color difference ΔE^{94} is measured as a measure for the amount of chalk that remains on the surface. The lower the ΔE^{94}, the better the dry erasability of the chalkboard surface.

The write and erase cycles and their subsequent measurement are repeated 25 times and averaged as the final result for the writeability and dry erasability of chalk.

Reference norm/specification or document: PVNV 41.810 and PVNV 41.811

In practice: The e³ CeramicSteel chalkboard surface is a matte surface. Its low gloss is caused by a rough surface, which is obtained by choosing appropriate raw materials and production parameters. This surface roughness determines the functional properties of the chalk board surface writeability and erasability. Should the surface be too rough, it would show excellent writeability since the surface would take up a lot of chalk and yield high contrast of the chalk writing. However, a too rough surface would also show poor, erasability because the chalk would be harder to remove out of this rough surface by the eraser. Conversely, should the surface be too smooth, writeability would be poor but erasability would be excellent. e³ CeramicSteel has been optimized to have the best balance between good contrast of the writing and ease of erasability.

Note: Poor wet erased lab sample shown for illustration of ghosting

22. Wet erasability of chalk | PVNV 41.812

Test description: The test consists of writing on the surface with high manual pressure on the chalk (which significantly aggravates ghosting) and subsequent cleaning the surface using tap water and a sponge only. The sample is then dried, and the color difference ΔE^{94} of the treated portion of the sample versus the untreated portion is a measure of the wet erasability of chalk.

Reference norm/specification or document: PVNV 41.812

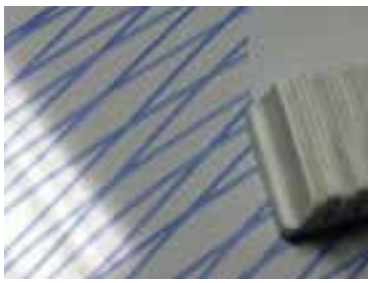
In practice: This test evaluates the wet erasability of the e³ C CeramicSteel chalkboard surface, since chalkboards are often erased and/or cleaned using water. Although, this yields a very clean chalkboard surface, some ghosting might occur after the water has dried. Ghosting is the faded reappearance of wet erased chalk writing after the water has dried, and must be within specification to avoid being visually disturbing.

23. Chalk consumption | PVNV 41.813

Test description: This property determines the amount of chalk consumed per 200 rm chalk writing on the sample to be tested. Weight-loaded chalk is dragged over the surface after the original weight is measured. The weight of the chalk is then determined again, and the weight loss is a measure of the chalk consumption of the surface.

Reference norm/specification or document: PVNV 41.813

In practice: Although when a chalkboard surface is used part of the chalk stylus remains on the surface, which determines the writeability (see above), another part will not and thus falls to the ground. This test provides not only the chalk consumption but also gives an idea of the related dust production, an important property to end users. This test ensures that chalk consumption and dust production are low.



24. Dry eraseability of drymarkers | PVNV 41.803

Test description: This test consists of multiple cycles of writing, drying and dry erasing the surface to be tested in a standardized way. The surface is written on to obtain a given scripture density per m^2 within 10 seconds, the scripture is left to dry for 10 seconds and subsequently erased for 10 seconds with a felt eraser at normal hand pressure. This cycle is repeated 10 times, which will leave drymarker pigment residue on the surface. The more pigment remains on the surface, the poorer the dry erasabilty is, which can be quantified by color difference measurement between treated and untreated parts of the sample.

Reference norm/specification or document: PVNV 41.803

In practice: Dry erasability of whiteboard surfaces is an important functional property of e³ CeramicSteel. It is greatly influenced by different factors such as the cleanliness of the surface, its gloss level, the type and quality of drymarker used and even the eraser. For example, when the surface has been cleaned repeatedly with liquid detergents, it is possible the soap builds up onto the surface, which is known to negatively influence the dry erasability. As explained before, the gloss level of the surface is also important, since the smoother a surface is, the glossier it is, and the better its erasability.

25. Eraseability of water-based markers with water | PVNV 41.822

26. Eraseability of permanent markers with alcohol | PVNV 41.822

Test description: After 50 cycles according to the above dry erase test, the sample is cleaned wet, using either i) water and a cotton cloth, ii) lukewarm water with 0.5% liquid soap and a cotton cloth, iii) alcohol and a cotton cloth and iv) acetone and a cotton cloth. When the color difference ΔE^{94} caused by any marker pigment remaining on the surface after cleaning reads below $\Delta E^{94} = 0.5$, the wet erasability for that cleaning agent is classed as excellent. When cleaning permanent marker off the surface, alcohol must be used, and when the color difference ΔE^{94} caused by any permanent marker pigment remaining on the surface reads below $\Delta E^{94} = 0.5$, the wet erasability for permanent markers is classed as excellent.

Reference norm/specification or document: PVNV 41.822

In practice: This test evaluates the wet erasability of e³ CeramicSteel whiteboard surfaces. Since there are many different drymarkers on the market, with significantly different dry erasability quality levels a wet erasing step may be needed to clean the surface from time to time. In practice, this test shows that when a water- (or alcohol-) based drymarker is used, the accumulated drymarker ink residue can always be cleaned off the surface using water, or at worst lukewarm water with a bit of soap so all pigment residue is removed leaving no visually detectable color difference from a totally clean surface. The same is valid for permanent markers, which are always removable with alcohol or at worst another suitable solvent to obtain a clean surface.

(loss of gloss and erasability -left- of a poor whiteboard surface – exaggerated test for illustration purpose)

27. Durability | PVNV 41.809

Test description: The test consists of erasing the surface with a contaminated felt eraser 100 times at high hand pressure. As contamination, very fine silica is to mimic the dirt and sand a dropped eraser picks up. Then the relative gloss change is measured and expressed in the percentage of the original gloss. The dry erasability is tested on the worn whiteboard surface and measured according to the dry erasability test.

Reference norm/specification or document: PVNV 41.809

In practice: This test simulates the wear and tear of the surface mimicking an eraser that has been dropped on the floor and picked up dirt. Since sand is very hard, a contaminated eraser will wear the surface as a function of time, and thus the gloss and/or dry erasability can deteriorate. Since most organic coatings have poor mechanical properties such as scratch and wear resistance, they will also exhibit poor durability as opposed to e³ CeramicSteel.

28. EN ISO 28762: Vitreous and porcelain enamels – enamel coatings applied to steel for writing surfaces – specification | EN ISO 28762

29. European Enamel Authority | EEA Quality Requirements

30. MBDC Cradle to Cradle Certified^{CM}

31. PEI 1002 compliant | PEI 1002

32. ISO 9001 compliant | ISO 9001

PolyVision e^3 CeramicSteel is certified and/or fulfills these international standards. Many of the tests and specifications described in this document are quality requirements within these international standards, and PolyVision is certified to comply with these standards by being periodically audited by an independent, external body.

Websites:

- iso.org
- european-enamel-authority.org
- mbdc.com
- porcelainenamel.com

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Environmental Policy: PolyVision strives for continuous improvement in all areas of environmental stewardship – responsible use of raw materials and natural resources, design processes and operation of all facilities – to protect, replenish, and restore the communities in which we live and serve.

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