CONFINDUSTRIA CERAMICA

EFFECT OF CLEANING PRODUCTS ON SURFACES

Comparing the chemical resistance of different materials

March 2021

The global pandemic situation has led each of us to analyze from a different perspective our own living situation, both in terms of space and in terms of the healthiness of our homes. **Aspects that contribute to increasing the hygiene of the environments in which we live are gaining particular importance.**

One of the main actions taken to reduce the spread of Covid-19 is to **disinfect spaces with harsh chemicals**, which can affect coating materials. However, **not all materials used for floor and wall surfaces react the same way to these sanitizers**.

Ceramic materials are resistant to chemical agents and represent a **hygienic solution**, helping keeping environments **healthy**. Molds, fungi and bacteria frequently attack certain flooring materials if not cleaned often with specific **products**; the latter can be more **aggressive**, and lead to the **loss of the aesthetic qualities and technical performance** of the materials.

Below are summarized three studies on the subject; these test the chemical resistance of different flooring products. These tests are carried out following specific regulations or simulating real conditions, such as normal cleaning conditions or an accidental spillage of the product on the floor. In the latter case, two scenarios are reproduced: in the first the spilled product is quickly removed, while in the second it is not, leaving it on the surface for a day.

1. ITC STUDY

1.1. Methodology

The study[1] considers **six types of flooring materials**, for a total of 23 samples:

- 7 ceramic products(5 BIa, 2 BIIa);
- 3 plastic-based resilient products (*plastic based materials* - PBM), like LVT (uses: light, medium and high-intensity);
- 3 laminates (uses: light, medium and high-intensity);
- 3 wood products (light natural, dark natural, mutilayered painted);
- 4 carpet (2 in natural fiber and 2 in synthetic fiber);
- 3 natural stones.

All materials have been tested for resistance to the following **cleaning and/or disinfection chemical products**: bleach (sodium hypochlorite), ammonia, caustic soda (sodium hydroxide), citric acid, muriatic acid (hydrochloric acid), lactic acid, acetone.

The tests simulated real situations:

- Conventional cleaning: the diluted product is placed in contact with the surface for 24 hours;
- Conventional cleaning with subsequent rinsing: the diluted product is placed in contact with the surface for 30 minutes;
- Accidental spill: the concentrated (as it is normally sold) product is placed in contact with the surface for 24 hours;
- Accidental spill with subsequent rinsing: the concentrated (as it is normally sold) product is removed after 30 minutes.

The samples were then evaluated based on the visual classification described in UNI EN ISO 10545-13:2017 to determine any changes in color, appearance, brightness, etc.

1.2. Results

In order to facilitate the comparison between the different materials, the study presents a table, which refers to situation of prolonged contact (24 hours) for both concentrated and diluted products, and summarizes the observations made. According to the color code used, the materials that resist to concentrated products are represented in green; the other colors show the different resistance to diluted and/or concentrated solutions.

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1 ITC (2020). Mejora de las prestaciones de baldosas cerámicas para rehabilitación de pavimentos interiores (PRESTILE). URL: http://py.itc.uji.es/fichaPY.aspx?idProy=%272165%27.
This document is a summary made by Confindustria Ceramica of a part of the hereby mentioned study conducted by ITC.

		Bleach	Ammonia	Caustic soda	Citric acid	Muriatic acid	Lactic acid	Acetone
Ceramic tiles	BIa unglazed natural							
	BIa unglazed semipolished							
	BIa unglazed non-slip							
	BIb glazed polished							
	BIIb glazed non-slip							
PVC	Light							
	Medium							
	High-intensity							
Laminate	Light							
	Medium							
	High-intensity							
Wood	Light natural							
	Dark natural							
	Multilayer							
Carpet	Synthetic polypropylene							
	Natural wool							
	Synthetic polyamide							
	Vegetal sisal							
Natural stone	Beige polished							
	Grey polished							
	White polished							

	24-hour contact with concentrated product: no visible effects
	24-hour contact with concentrated product: color change, brightness change
	24-hour contact with diluted product: color change, brightness change
	24 hours contact with concentrated product: loss of material, surface deterioration, change of appearance
	24 hours contact with diluted product: loss of material, surface deterioration, change of appearance

The following are the **findings** of the **ITC study**:

CERAMIC TILES They have a **high resistance to different chemical agents**. Among the tested materials, only the polished sample shows a slight damage when in contact with strong basic products (sodium hydroxide solution) for long period (24 hours), while another sample shows a slight damage against acids.

RESILIENT PVC FLOORINGS **They behave differently depending on the composition of the surface coating.** Two of the three samples tested showed high surface deterioration for a short-term contact (30 minutes) with acetone. In addition, some samples are also damaged by chemicals such as sodium hypochlorite, ammonium chloride, and sodium hydroxide.

LAMINATES They have **good chemical resistance**, except for hydrochloric acid, which damages this material not only when it's used in diluted form and but also when the concentrated product is accidentally spilled.

WOOD **It shows surface alterations with many of the agents used in the study.** All of the wood products tested are attacked by sodium hypochlorite, ammonium chloride, and sodium hydroxide, even with short-time exposures. Two of the three samples tested also show color changes upon contact with dilute hydrochloric acid. One of the tested samples is not resistant to acetone.

CARPET **The chemical resistance of carpet depends on its composition**: polypropylene and natural wool carpets have a good performance with the agents used; the rest of the samples show a significant change in appearance when in contact with sodium hypochlorite, even if diluted. Similarly, polyamide carpet discolors with sodium hydroxide solution.

NATURAL STONE **The least resistant** - among the samples tested - **to chemical detergents** is natural stone. All the tested samples showed remarkable superficial alterations due to the contact with acids (even when diluted and for short-time exposure). Contact with sodium hypochlorite, ammonium chloride and sodium hydroxide causes alterations in color and gloss.

2. CENTRO CERAMICO STUDY

2.1. Methodology

The study[2] focuses on **two LVT products** widely used in the European market, and uses analysis and test methods typical of the characterization of ceramic surfaces. The following were carried out: measurement of contact angle, microstructural analysis, analysis of surface roughness and texture, determination of slip resistance, determination of joint impermeability in the installed system, determination of surface hardness, **resistance to chemical attack and staining**.
We report the results of the last two characterizations, which were carried out in accordance with ISO 10545-13, ISO 10545-14 and an in-house method of Centro Ceramico.

Regarding **stain resistance**, the following staining agents were used:

- iodine in alcoholic solution (13 g/l) (ISO 10545-14)
- chrome green in light oil (ISO 10545-14)
- olive oil (ISO 10545-14)
- potassium permanganate in aqueous solution (10 g/l) (Centro Ceramico in-house method)
- blue ink for ink pads (stamps) (Centro Ceramico in-house method)
- permanent red ink (marker) (Centro Ceramico in-house method).

2.2. Results

One of the **LVT** samples was damaged by the alkaline potassium hydroxide solution at both low (30 g/l) and high (100 g/l) concentrations, indicating **poor resistance to all alkaline cleaners**.

Olive oil and chrome green stains were removed - as per ISO 10545-14 (Procedure B) - using mild soap and a soft sponge. **Iodine stains** could not be removed neither by running hot water (ISO 10545-14 Procedure A) nor by neutral soap and a soft sponge (ISO 10545-14 Procedure B). Procedure C of ISO 10545-14, which involves the use of a hard-bristled rotary brush, is not applicable here, since it leads to permanent surface damage (Figure 1).
The **potassium permanganate, blue ink for ink pads and permanent red ink stains** from the in-house Centro Ceramico method were found to be non-removable by washing with hot running water, or with neutral, alkaline and acidic detergents manually with a soft sponge. The Centro Ceramico method also foresees, after the manual cleaning methods, the use of a rotating brush with hard bristles that, as in the case of ISO 10545-14 Procedure C, is not applicable, since it leads to a permanent damage of the surface.

[2] Centro Ceramico (October 2019). *LVT – Luxury Vinyl Tiles*. Presentation of the results of the tests supporting the Fraunhofer-Institut für Bauphysik IBP study (cfr. note 3).

Figure 1: Test for the determination of stain resistance

3. FRAUNHOFER IBP STUDY

3.1. Methodology

The study[3] has compared the performance of **ceramic tiles** with one of the most popular LVT floorings products in the European market, carrying out tests both on sigle products and on flooring systems. The analysis focused on: microbial resistance, water resistance, **chemical resistance**, fire resistance, thermal resistance, evaluation of the toxicity, life cycle assessment (LCA)[4].

For chemical resistance, in accordance with ISO175:2011-03 and ASTM F925-13, one of the tests carried out is aimed at examining the resistance of the two materials to solvents, in particular:

- water (pH 1, 3, 7, 10, 12, and 14),
- ethanol,
- ethylacetate,
- tetrahydrofurane,
- toluene,
- petroleum benzene.

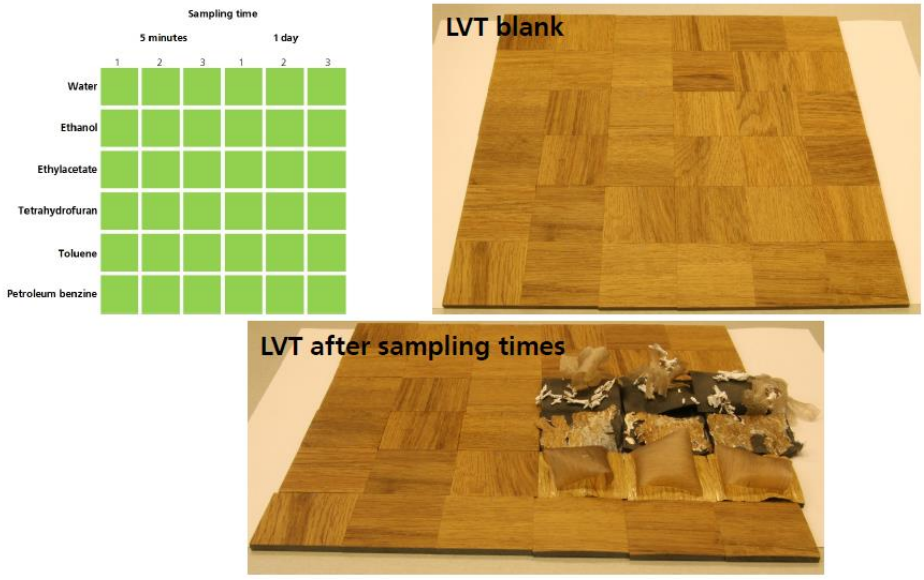
[3] Fraunhofer-Institut für Bauphysik IBP (2019). Comparison of Ceramic Tiles and LVT" (report UHS-022/2019). This document is a summary made by Confindustria Ceramica of a part of the study "Comparison of Ceramic Tile and LVT" (report UHS-022/2019) conducted by the Fraunhofer-Institut für Bauphysik IBP.

[4] A summary of the study in its entirety is included in the document "Ceramic tile and Plastic Based Materials, Summary of the Fraunhofer IBP comparison study on tiles and LVT (report UHS-022/2019)", published in 2019 by Confindustria Ceramica.

3.2. Results

Sampling time	Chemical resistance		Comment
	Ceramic	LVT	
Short term (5 min)	✓	✓	**No visible change** has been observed on the performance of both ceramic tiles and LVT.
Long term (24 h)	✓	X	**Ceramic tiles** show a much **better resistance to the solvents**. **LVT** showed effects of significant **swelling and delamination** of wear-coating and photographic print film by contact with ethyl acetate, tetrahydrofuran, and toluene, and **color change** when in contact with ethanol and petroleum benzene.

Figure 2: Resistance of LVT samples to chemical agents



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