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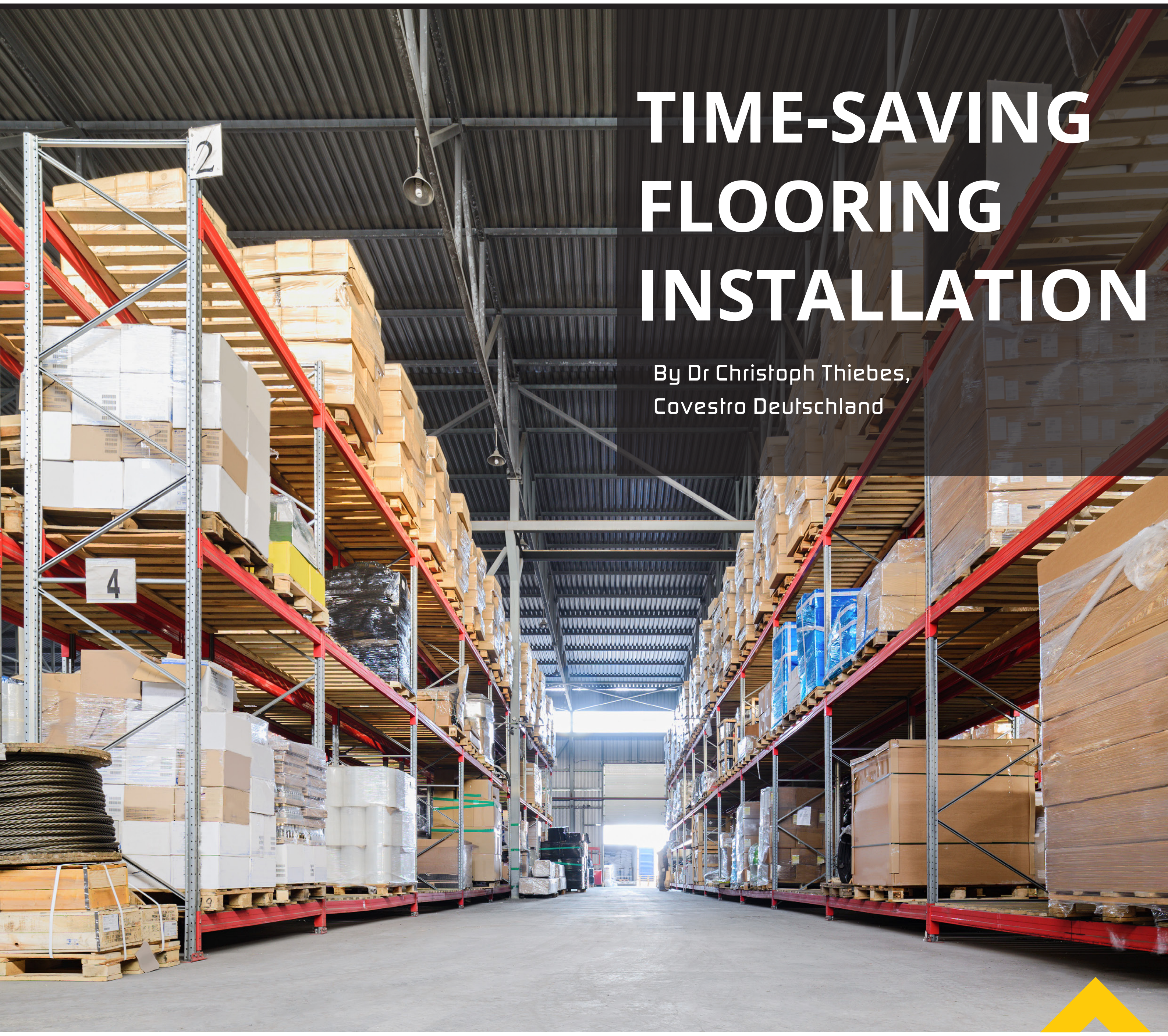

TIME-SAVING FLOORING INSTALLATION

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TIME-SAVING FLOORING INSTALLATION

Comparing a new, ultra-fast curing technology for primers with established technologies. By Dr Christoph Thiebes, Dr Matthias Wintermantel and Contardo Pafumi, Covestro Deutschland.

Epoxy (EP) and moisture-curing polyurethane (PU) systems are mostly used today as reactive primers for preparing substrates before floor coating or installing parquet and other floor coverings. Our comparative tests show that primers based on polyaspartics (PAS) have properties that are comparable to these established systems but cure much faster. We demonstrate the practical benefits of using this new system in an example of coating the concrete floor of a supermarket in Greece.

Polyaspartic acid esters (polyaspartics) have been in use since the 1990s. Originally, they were used as reactive diluents that helped to reduce the volatile organic compounds (VOC) in conventional 2-component polyurethane coatings (2C-PU). Polyaspartics are formed during the reaction of sterically hindered secondary diamines – polyaspartic acid esters – with aliphatic polyisocyanates (*Figure 1*). The reaction rate depends largely on the hydrocarbon groups on the aspartics and the aliphatic group selected for the polyisocyanate. That choice also influences hardness, chemical resistance and other essential coating properties of the resulting products.

MOVING ON FROM THE STATUS QUO

With the development of low-viscosity raw materials in the early 2010s, polyaspartic technology penetrated the floor-coating market [1], with solvent-free coatings being applied with a roller or trowel. Until now, polyaspartic technology for floor coatings has focused on highly resistant top and intermediate layers [2]. We have shown that this technology also offers interesting advantages for primers on substrates like cement screed. In response to market needs for systems which can significantly speed up flooring installation, we have been investigating the suitability of this technology for applications in which an adhesive is applied to the primer, such as when installing wood flooring with adhesives (*Figure 2*). A primer performs one or more of the following functions in these applications [3, 4]:

- It enhances the adhesion of the adhesive, especially if the substrate is porous or dusty despite cleaning.
- It shields the adhesive from the residual moisture of the fresh substrate – e.g. cement screed, particularly while the adhesive is being applied and is curing,
- It prevents damaging interactions between plasticisers and other ingredients in the adhesive and the substrate.

RESULTS AT A GLANCE

- → Polyaspartic technology enables fast curing primers for floor coatings and the installation of floor coverings.
- → Properties of new and established primers tested are on a comparable level
- → Compatibility of polyaspartic primers with the tested adhesives technologies is excellent.
- → Polyaspartic primers allow installation of wood floor coverings after 1.5 hours, enabling shorter down times and economic advantages for craftsmen and building users.

Figure 1: Reaction of polyaspartic acid esters with aliphatic polyisocyanates.

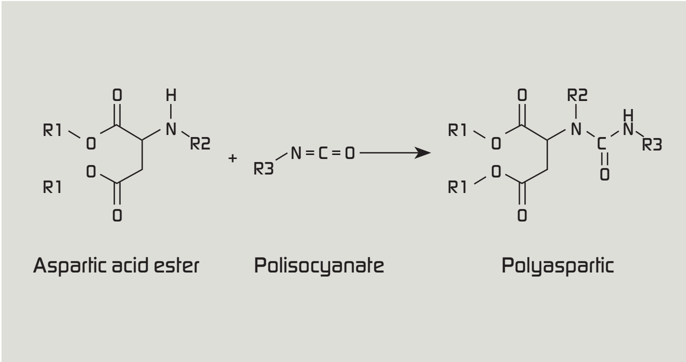
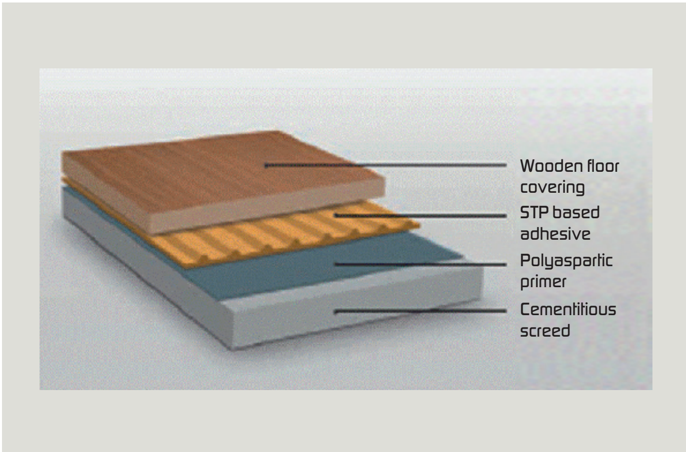


Figure 2: Schematic structure of floor coverings.

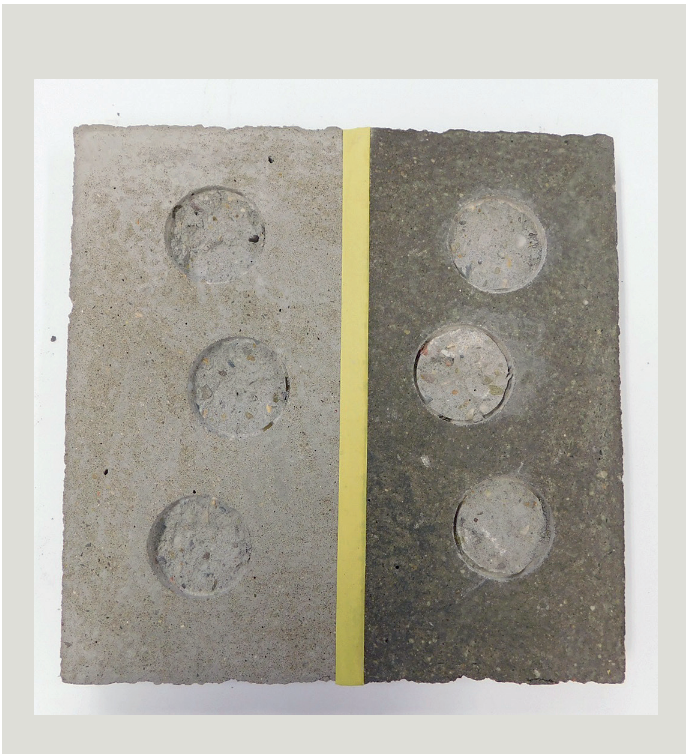


At present, solvent-free 2C-EP systems are leading reactive primer technologies for floor coatings and bonded wood floor coverings. Moisture-curing PU primers are also frequently used. For this reason, two of these systems served as comparison benchmarks for tests on a prototype primer formulation based on PAS.

EXCELLENT ADHESION TO THE SUBSTRATE

To examine how primer systems adhered to a typical substrate, tensile strength was measured on cement screed panels coated with the respective primer system. The EP and PAS primers had been prepared immediately before by thorough mixing. One half of the cement-based screed panel was coated in each case. After primers were cured under standard conditions (23 °C, 50 % relative humidity) for three days, three circular contours with a diameter of about 5 cm each were milled into the upper sides of the primed and un-primed parts of the screed panel, each approximately 5 mm deep. Dollies were glued into the circles with epoxy resin adhesive. After 24 h storage under standard conditions, the surface deductibility was determined using an adhesion test system. The results were comparable for all the systems and confirmed excellent adhesion to the substrate for the PAS system (*Figure 3*) and the two other primer systems. In all tests, the failure occurred deep inside the cement screed panel, with comparable adhesive tensile strengths of 1 N/mm^2 for all primers (2C-PAS, 2C-EP and 1C-PU).
To further investigate the potential for the PAS system, a comparable test was repeated with a hard concrete slab. In this test, an adhesive tensile strength of more than 3 N/mm^2 was achieved, at which point a fracture was observed in the concrete.

Figure 3: Cement screed panel coated with 2C-PAS primer after determining adhesive tensile strength.



EXCELLENT WATER-VAPOUR BARRIER

To test the barrier effect of the various primer systems against water, two layers of each of the respective primers (coating weight 276 g/m² for 1K PU, 250 g/m² for PAS and EP) were applied to cement screed discs, where they cured for at least three days at standard conditions. The discs were glued as lids to the rim of a coated metal can, which contained a specific amount of water. The weight of the cups was then measured over the course of 28 days. It was found (*Figure 4*) that much more water evaporated from cups with uncoated cement screed lids than from cups with lids coated with the respective primers. 1C-PU and 2C-PAS primers proved to be an effective barrier and allowed about the same amount of water vapour to pass through. The 2C-EP system performed even better.
Tests for adhesive strength and water-vapour permeability are important both for primers that are part of multilayer floor-coating systems and for primer layers onto which an adhesive layer is applied. Subsequent comparative tests are only of interest for adhesive applications.

FAST ADHESIVE APPLICATION NOW POSSIBLE

To investigate the influence of the primer on the rate of strength development of the adhesive formulation based on a silane-terminated polymer (STP), adhesive joint parts were made in which one of the two bonded components (beech wood) was coated with the respective primer. We varied the time between applying the primer and the adhesive.
For this purpose, specimens made of two pieces of beech wood with an overlap length of 1 cm and an adhesive gap thickness of about 1 mm were used. One of these pieces of wood was coated with the primer over its entire surface, the other one remained uncoated. The coated pieces were subsequently stored for different times:
› 4 hours at room temperature
› 24 hours at room temperature
› 24 hours at room temperature followed by 72 hours at 50 °C.

The STP adhesive was applied after this waiting period and the second, uncoated piece of wood was placed on top. The resulting test specimens were stored in a suitable fixture with the aid of metal plates to adjust the thickness of the adhesive gap for different times and under different conditions (*Figure 5*). Following the storage, the lap-shear strength of the joint parts was measured using a tensile testing machine.
The results (*Figure 5*) show two tendencies. The STP adhesive cures reliably on the polyaspartic primer and the lap-shear strength of the joined test specimen increases with increasing storage time. The time

Figure 4: Evaluation of water-vapour diffusion resistance.

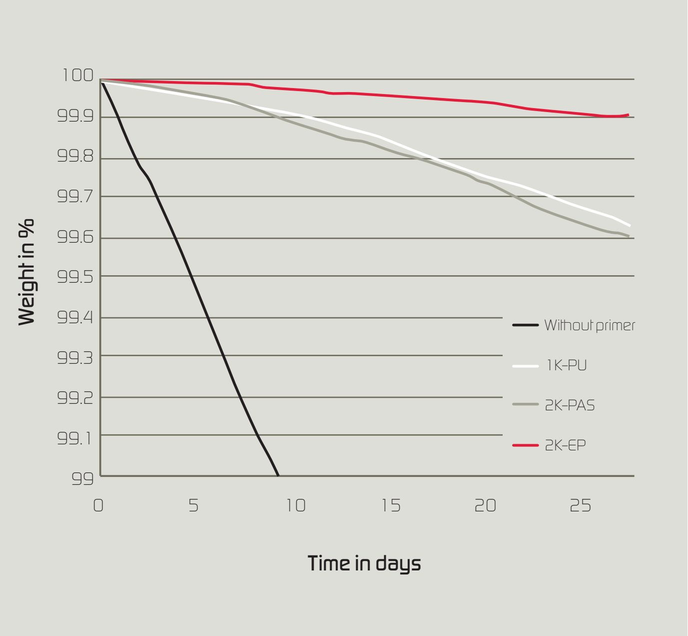
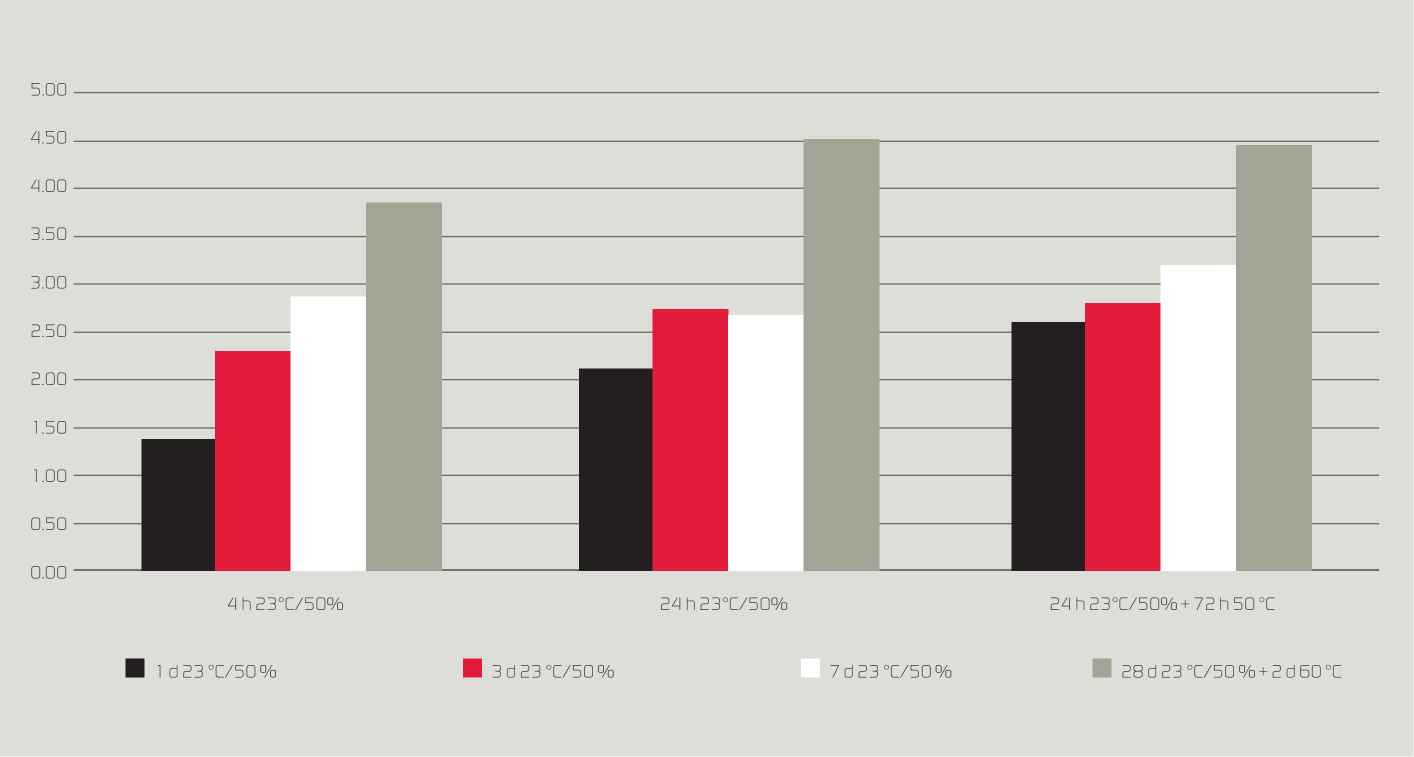


Figure 5: Development of lap-shear strength (y-axis [N/mm²]) after different polyaspartic primer curing times.

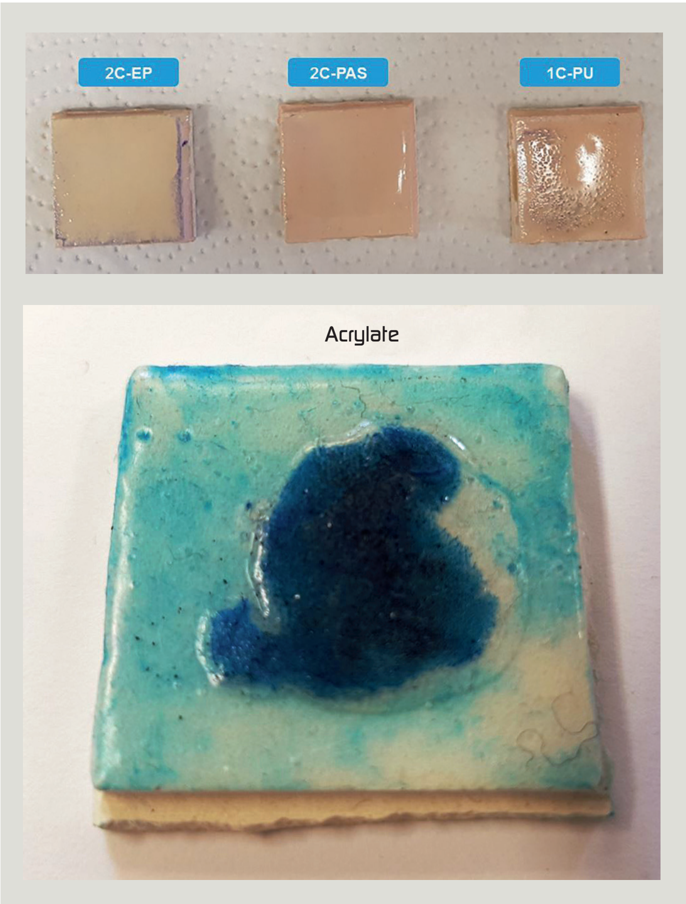


between applying the primer and the STP adhesives (waiting period) after the polyaspartic primer has been applied is of secondary importance for the lap-shear strength. Overall it can be stated that predominantly cohesive failure of the adhesive can be observed; in some areas, the primer separates from the wood, while the adhesion from primer to adhesive is excellent.

Another polyaspartic primer was tested in comparison to a moisture-curing 1C-PU primer after waiting periods of only 30 and 60 min respectively, using the STP adhesive formulation. In case of the 1C-PU primer the adhesive cured slowly and incompletely after 24 hours under standard conditions if it was applied after a 30- or 60-min waiting period respectively. Tensile tests performed after 24 h of curing done on the test specimens showed failure at low strengths, and the adhesive residues remaining on the substrate were still sticky. For the polyaspartic primer there was no significant difference between the lap-shear strengths achieved after 30 min and 60 min (2.8 N/mm^2). The lap-shear strength obtained with the 1C-PU primer after 60 min only reached 50 % of that of the 2C-PAS primer after a 30-min waiting period, so the 2C-PAS was clearly superior in that respect.

Further testing of lap-shear strength development using the polyaspartic primer was done with adhesives that were commercially available. Testing comprised three silane-based adhesives (one of them not formulated with plasticising components) as well as a 1K-PU and a 2K-PU adhesive. The adhesives were applied onto the polyaspartic primer after a waiting time of 60 minutes and the lap-shear strength of the specimens was tested 24 hours after adhesive application. In all cases the lap-shear strength reached or exceeded 90% of the strength of the control specimens with the same adhesives that were made from wood not coated with a primer. In case of the 2K-PU adhesive, lap-shear strength levels exceeding 5 N/mm^2 were reached with the polyaspartic primer.

Figure 6a, 6b: Clay tiles coated with different primers and exposed to the stained plasticiser diisononyl phthalate for 7 days at room temperature.

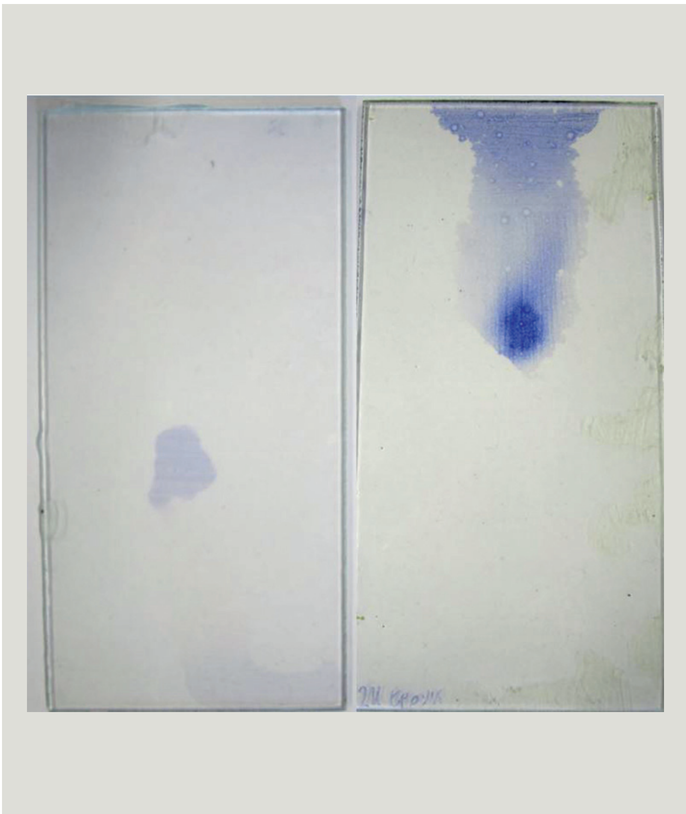


RESISTANT TO PLASTICISERS

Adhesives often contain plasticisers. It is therefore important to check the extent to which these plasticisers can affect polyaspartic primers. For this purpose, clay tiles that were pre-treated with an acrylic primer were coated with a 1C-PU, an 2C-EP and a 2C-PAS primer. After complete curing, the plasticiser diisononyl phthalate containing a solvent dye was dropped onto the plates. After 7 days' storage at room temperature, these drops were removed by wiping and the tiles were optically patterned. It was determined (*Figure 6a*) that none of the clay tiles pre-treated with any of the reactive primers showed significant changes or softening. An acrylic primer tested for comparison on a clay tile without reactive primer (*Figure 6b*), on the other hand, had been softened by the plasticiser over a large area, which could be recognised by the fact that the coloured ink had run off and could no longer be removed from the sheet.

The 1C-PU primer showed only slight discolouration within the areas covered by bubbles on the surface, but remained unchanged in the other areas. Whereas under these test conditions no significant differences were discernible between 2C-EP and 2C-PAS primers with regard to resistance to the plasticiser diisononyl phthalate, during an even more demanding test where glass plates served as the substrate differences were observed. In this test, the plasticiser was applied for seven days – not at room temperature, but instead at 50 °C. The result is shown in *Figure 7*: The PAS primer resisted the plasticiser better than the EP primer, where a clearly visible discolouration was observed.

Figure 7: Glass tiles coated with primers and exposed to the coloured plasticiser diisononyl phthalate for 7 days at 50°C.



SHORT WAITING TIME, HIGHEST PRODUCTIVITY

The enormous advantage of polyaspartic primers is that parquet or other floor coverings that are glued to the floor can be installed within a brief period after applying the primer. The primer is already cured after 1.5 hours to the extent that the surface can be walked on and the adhesive can be applied. This would be a significant time reduction compared to other established systems, because some 2C-EP primers require up to 16 hours to form a non-adhesive surface that can be walked on. Some classical 1C-PU primers have a waiting time of up to 12 hours, to prevent side reactions with some adhesives.

On new or highly absorbent substrates, it may be necessary to apply two coats of primer. Here, the polyaspartic primer provides further time savings. This is particularly significant when compared to the EP primer. In addition, PAS primers allow greater film thicknesses to be achieved than PU primers, and without significant bubble formation.

The example of a warehouse in a supermarket in Zografou, Greece, shows how economically beneficial it can be when as little time as possible lapses between the start of the work and walkability. The existing coating on the concrete floor of this hall, which covers an area of 250 m², had partially detached itself due to lack of impact resistance and insufficient adhesion. When the food retailer My Market, which originally started in the Athens region with 66 stores, took over a chain of supermarkets, it had to redesign stores throughout the country in a short period. During the renovation of the Zografou warehouse, My Market's key requirement for a new floor coating was that it should be ready for full completion within one day. The only time window was Sunday, because the supermarket was to remain open from Monday morning to Saturday evening as usual. The work was achieved within one Sunday with a rapid coating system from Greek paint manufacturer Neotex. The multilayer system including primer is based on "Pasquick", our polyaspartic technology.

AND TO TOP IT ALL OFF, LOW EMISSIONS

Building products can contribute to indoor pollution with volatile organic compounds (VOC). Polyaspartic technology can be used to create primers that emit only low amounts of VOCs. Tests on reference formulations revealed that they met the criteria for the German AgBB scheme (Committee for Health-related Evaluation of Building Products).

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