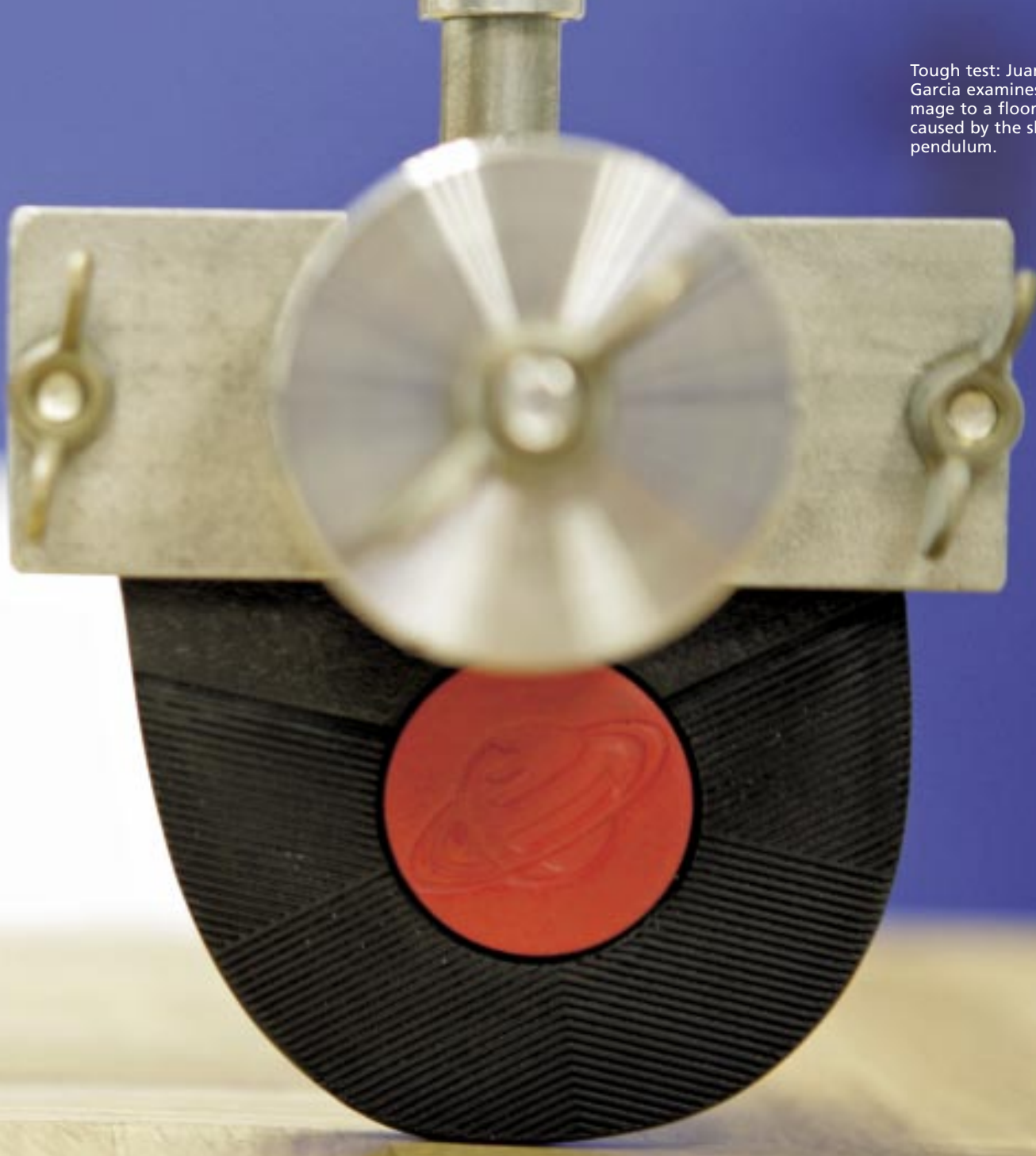


Solvent-free coatings for parquet floors

A top-class finish

Parquet floors are currently right in fashion, whether laid in the 'ship's deck pattern' for the living room or the 'French herringbone' pattern for the ballroom. In Germany alone, more than 20 square kilometers of parquet were laid in 2004. For the sake of the environment, Bayer researchers have been upgrading their proven coating materials for hard-wearing parquet finishes. The quality of the new products is just as good as that of their predecessors, but they are now completely free of solvents.

Tough test: Juan Miguel Garcia examines the damage to a floor coating caused by the shoe sole pendulum.



At Bayer MaterialScience's Competence Center for Wood Coating Systems in Barcelona, the heel of a shoe sole – black rubber with a red button – suspended on a stainless steel pendulum grinds endlessly back and forth across a coated piece of beechwood. There is also a considerable amount of weight attached to it because it is simulating the step of a man weighing 120 kg. In such tests, it can get hotter under the sole than under the Mediterranean sun: "At worst, small leather particles from the sole literally melt into the coating," explains Dr. Christoph Irle. He and his

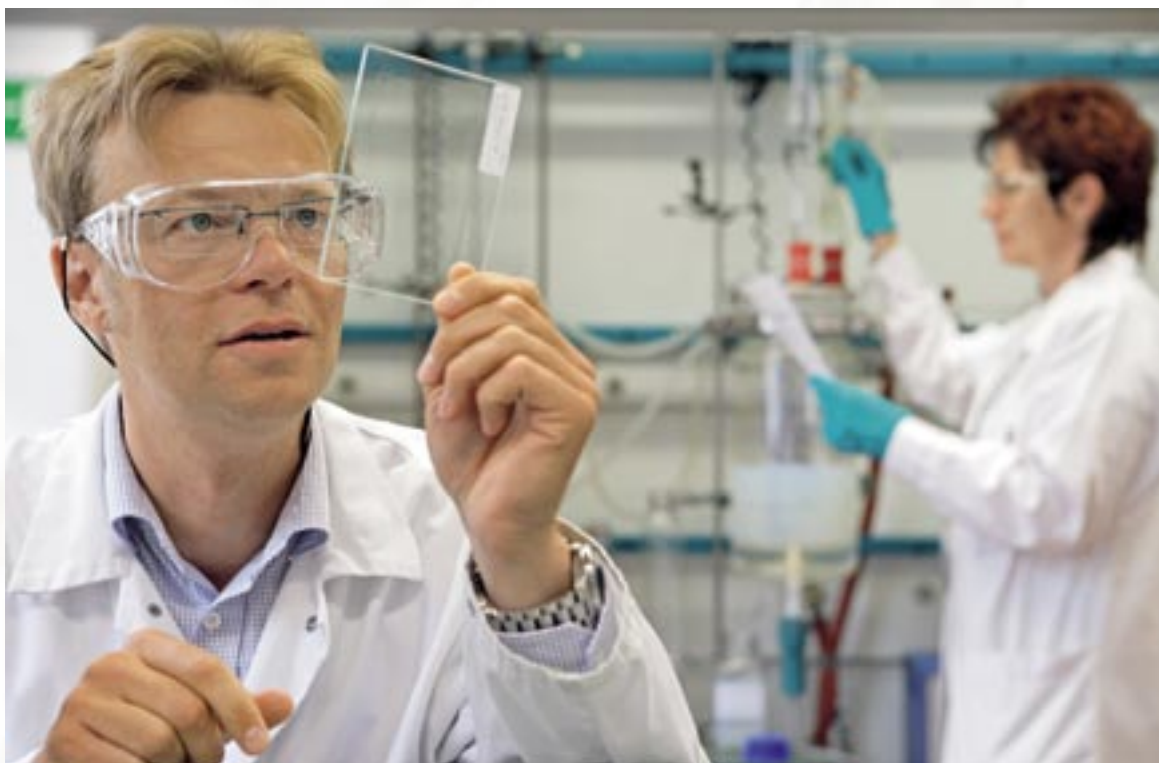
fellow chemists have plenty more tortuous tests up their sleeves to measure the wear resistance of these parquet finishes.

New coating doesn't give scratches a chance

They maltreat the finished wood with cleaning agents, they roll over it repeatedly with a leather roller and they pour coffee, red wine and high-percentage alcohol on it – the normal things a parquet floor has to tolerate every day.

On the Barcelona test stand today are some water-borne coatings based on the new Bayhydrol® range of solvent-free raw materials. These are milky looking liquids called dispersions in which nanometer-sized polyurethane beads are suspended. Because their network of compact and long-chain molecules makes them both hard and flexible, they are regarded as the non plus ultra among parquet finishes. This means that the finish is far more resistant to scratches and does not wear as quickly. Christoph Irle is very happy with the results of the hardness tests:

Clear as glass: Michaela Breithardt (right) produces the raw material that Dr. Rolf Gertzmann tests as a hardened coating.



“The solvent-free raw materials are absolutely equal to their predecessors in terms of quality,” he says. It is actually because of the solvent, N-methyl-2-pyrrolidone (NMP), that these coating raw materials were singled out for further development work. NMP is used in the production of conventional polyurethane dispersions, and tiny residues of it remain in the product after manufacture. The solvent is used not only in the chemical, pharmaceutical and oil industries, but also in many detergents. Recently, however, there have been suggestions that NMP in high concentrations may be harmful to the health.

Bayer’s research department therefore decided not to take any risks and successfully changed over production of the raw material in just 18 months. The new solvent-free polyurethane dispersions have been on the market since April 2005.

New solvent is recycled

Although the new coating materials do not contain any solvent at all after production, it is still indispensable for the actual production process. Dr. Rolf Gertzmann, who has been driving the changeover of the process at Bayer MaterialScience in Leverkusen,

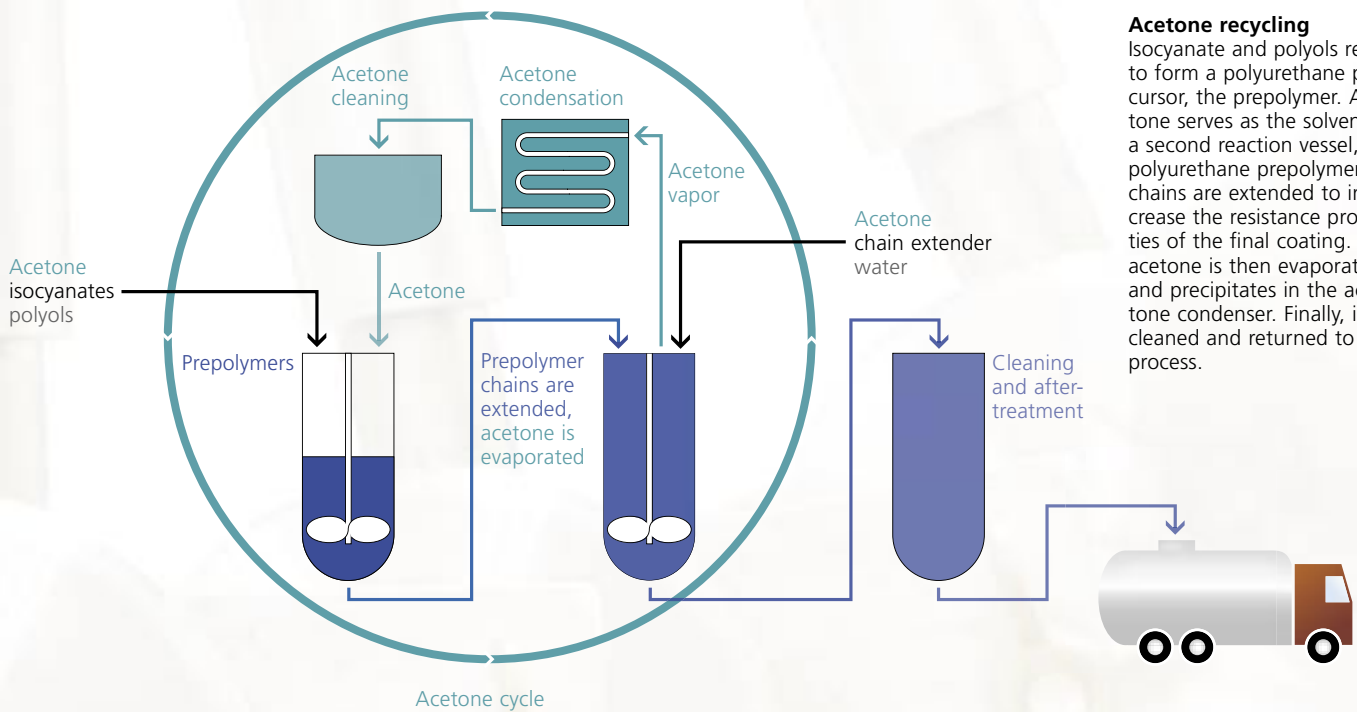
explains how they did it: “We replaced NMP with a solvent that can be completely removed from the product after production.” The solvent he was talking about is acetone. Unlike NMP, it boils at moderate temperatures and can therefore simply be evaporated off after the completion of raw material synthesis. It is subsequently cleaned and returned to the process. The scientists are well familiar with such recycling processes, because the acetone process has long since proved itself in the production of other polyurethane products like adhesives and textile coatings.

Synthesis of the polyurethane beads can basically be performed in the acetone solution in exactly the same way as before in NMP. In both cases, isocyanates and alcohols (polyols) link to form extended polyurethane molecules, which become entangled to form coils. The chain extenders, which join up several polyurethane molecules to form longer chains, are important synthesis auxiliaries for this process because the longer the chain, the more resistant the water-borne coatings formulated from them. Another important additive is dimethylolpropionic acid, DMPA. It acts as a hydrophilizing agent (from the Greek, meaning a product that makes a substance water-loving). It ensures that once synthesis is

Passing the tests with flying colors

With marks of five and four, the water-borne parquet coating based on NMP-free Bayhydrol® XP 2557 achieves very good results on the test scale, which ranges from zero to five.

Test	Brief information	Marks/results
Alcohol resistance	50 % alcohol, 30 min	5 : no change
Water resistance	24 h	5 : no change
Shoe sole resistance	A pendulum with a shoe sole scrapes over the finish	4 : a man weighing 120 kg would cause only minimal scratching
Drying rate		1.5 h
Pendulum hardness	A pendulum with a metal ball scrapes over the finish	The pendulum keeps swinging for 95 sec : The coating is hard
Abrasion resistance	A leather sole is rolled over the finish 1,000 times	With just 18 mg of abrasion, the coating is very flexible and resistant



Acetone recycling
Isocyanate and polyols react to form a polyurethane precursor, the prepolymer. Acetone serves as the solvent. In a second reaction vessel, the polyurethane prepolymer chains are extended to increase the resistance properties of the final coating. The acetone is then evaporated and precipitates in the acetone condenser. Finally, it is cleaned and returned to the process.

complete, the polyurethane particles can be mixed with water to create a stable dispersion and not end up as sediment.

Advantages for the surface finish, too

Besides the storage stability problems observed initially, the DMPA hydrophilizing agent also caused major problems during the changeover to the new medium acetone, in which it does not dissolve at all. Each one of the new products had to be individually modified to elevate the storage stability to the accustomed level. An apparently universal "trick" was developed for doing so: for the DMPA hydrophilizing agent, the chemists came up with a solubilizer that inserts itself like an adapter between the DMPA and the acetone. It literally pulls the dispersing auxiliary into the liquid. Consequently, the research team found that they could manage with a very small amount of solvent. The net result of the patentable modifications made to the formulation is a stable, solvent-free polyurethane dispersion.

To mix a water-borne parquet coating from a polyurethane dispersion, surface coating manufacturers need add only a few ingredients: Silica gel or waxes to produce the desired gloss, silicones to

prevent foaming, and a small amount of organic solvent. The polyurethane beads need the cosolvent to melt and thus form a homogeneous coating on the parquet floor. And the new raw materials have yet another important benefit: "The coating manufacturers now get by with a maximum of five percent cosolvent instead of the former nine percent," says Christoph Irle. "Our goal is to get this figure as near to zero as possible." Irle is hoping that the oscillating shoe sole will keep going till then because

a new test sole would first have to be painstakingly calibrated, and the tried-and-tested model is no longer available. The Spanish cobbler, from whom Irle's colleague originally bought the shoe, has now retired.

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Top-class finish: Dr. Christoph Irle in the parquet testing laboratory.

