



US 20050153141A1

(19) **United States**

(12) **Patent Application Publication**

Li et al.

(10) **Pub. No.: US 2005/0153141 A1**

(43) **Pub. Date: Jul. 14, 2005**

(54) **POLYURETHANE COATING CURE ENHANCEMENT USING ZIRCONIUM CARBONATE**

(22) Filed: **May 27, 2004**

Related U.S. Application Data

(75) Inventors: **Minyu Li**, Oakdale, MN (US); **Mark D. Levitt**, Saint Paul, MN (US); **Lauren K. Carlson**, Saint Paul, MN (US); **Robert D.P. Hei**, Baldwin, WI (US); **Nathan L. Damro**, Saint Paul, MN (US)

(63) Continuation-in-part of application No. 10/756,119, filed on Jan. 12, 2004.

Publication Classification

(51) **Int. Cl.⁷ C08G 18/00; B32B 27/00**
(52) **U.S. Cl. 428/423.1; 528/44**

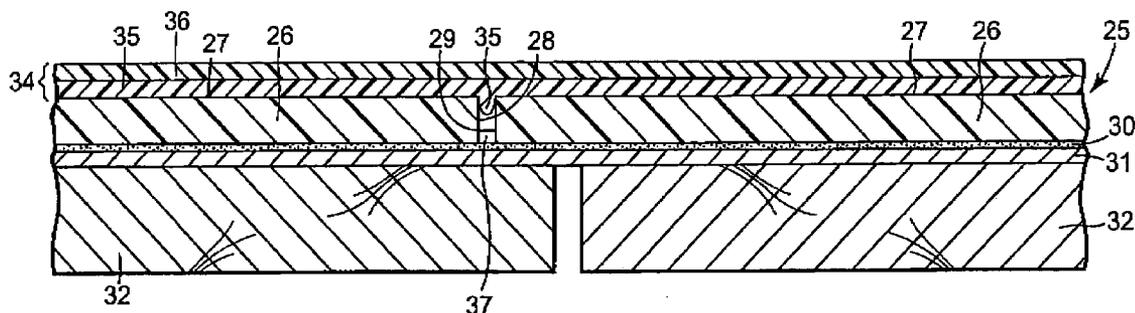
(57) **ABSTRACT**

Correspondence Address:
IPLM GROUP, P.A.
POST OFFICE BOX 18455
MINNEAPOLIS, MN 55418 (US)

Zirconium carbonates can initiate hardening of polyurethane coatings and decrease the coating tack-free time. The decreased tack-free times facilitate earlier application of additional polyurethane layers and earlier return of a coated article to service, and can provide improved floor finishes.

(73) Assignee: **Ecolab Inc.**

(21) Appl. No.: **10/855,931**



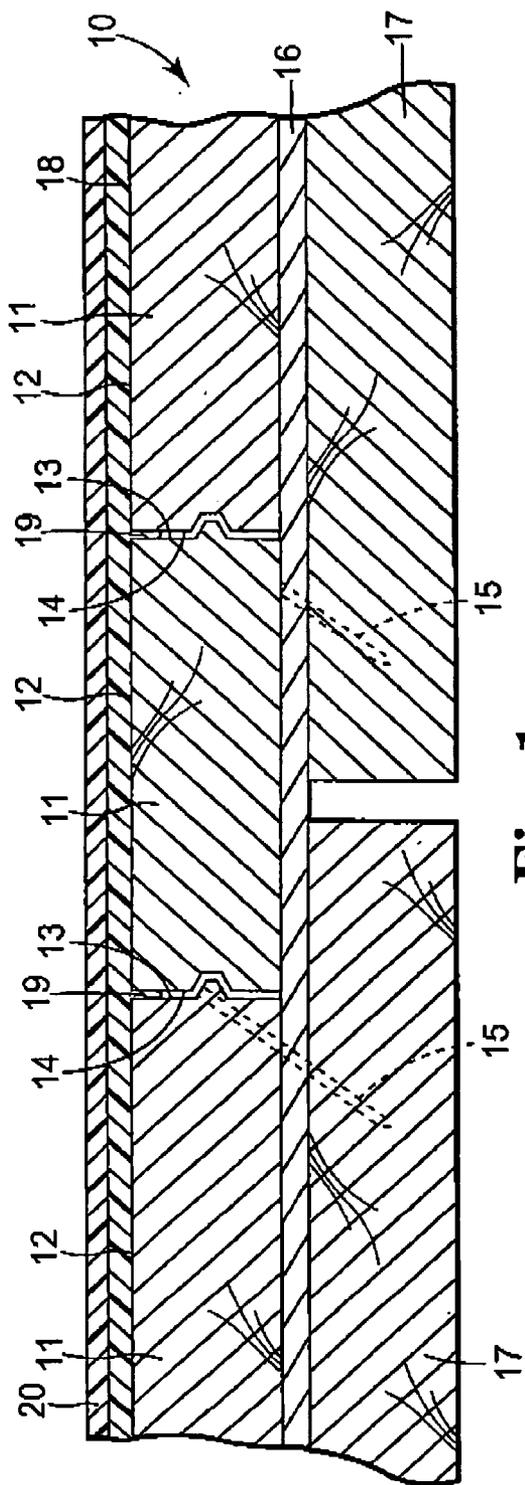


Fig. 1

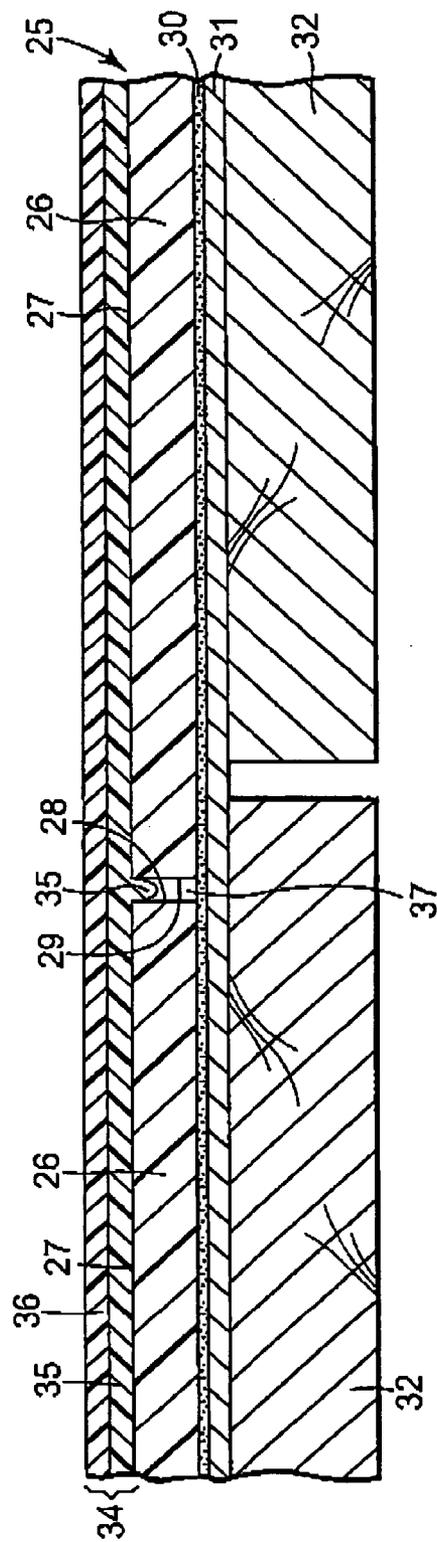


Fig. 2

**POLYURETHANE COATING CURE
ENHANCEMENT USING ZIRCONIUM
CARBONATE**

**CROSS-REFERENCE TO RELATED
APPLICATION**

[0001] This application is a continuation-in-part of and claims priority to U.S. patent application Ser. No. 10/756,119, filed Jan. 12, 2004, the disclosure of which is incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] This invention relates to hardenable polyurethane coatings, to methods for applying polyurethane coatings and to polyurethane coated articles.

BACKGROUND

[0003] Polyurethane coatings are widely used for applications in which a protective overcoat or film is desired. For example, two-component or so-called "2K" polyurethanes containing a polyol or polyamine first component and a polyisocyanate second component will react when mixed to form a durable film containing polyurethane or polyurea linkages. Unfortunately, 2K polyurethane coatings can have lengthy drying times. If uncatalyzed, the coating can take hours to become tack-free and days to harden completely. The hardening rate can be accelerated by adding a suitable catalyst or initiator. Although a variety of materials have been suggested for use as initiators, nowadays polyurethane coatings typically are hardened using an organometallic compound such as dibutyltin dilaurate, e.g. as in U.S. Pat. No. 6,316,535 B1.

[0004] Alternatives to zinc catalysts for 2K polyurethanes include those described in Florio, *Troubleshooting Metal Catalyzed Urethane Systems*, Paint & Coatings Industry (Sep. 26, 2000), available on the internet at http://www.pci-mag.com/CDA/ArticleInformation/features/BNP_Features_Item/0,1846,113,71,00.html, Stamenković et al., *Catalysis of the Isocyanate-Hydroxyl Reaction by Non-Tin Catalysts in Water Borne Two Component Polyurethane Coatings*, *Facta Universitatis Series: Working and Living Environmental Protection*, Vol. 2, No 4, pp. 243-250 (2004), available on the internet at <http://facta.junis.ni.ac.yu/facta/walep/walep2004/walep2004-02.pdf>, U.S. Pat. Nos. 5,965,686, 6,335,304 and 6,353,057 and European Published Patent Application No- EPO 509 437 A2. Commercial alternatives to zinc catalysts for 2K polyurethanes include K-KAT™ 348 and K-KAT XC-3203 bismuth carboxylate catalysts, K-Kat 5218 aluminum chelate catalyst, K-KAT 4205 and K-KAT XC-6212 zirconium chelate catalysts and K-KAT XC-A209 and K-KAT XC-9213 zirconium catalysts, (all available from King Industries, Inc.).

[0005] U.S. Pat. Nos. 5,608,000 and 5,610,232 describe aqueous dispersion adhesives of carboxylate-functional anionic polyurethanes and containing zirconium carbonate as a carboxylic acid reactive crosslinker. Other references relating to zirconium include U.S. Pat. Nos. 4,763,133, 5,494,705, 5,531,820, 6,113,989, 6,419,731 and 6,627,725, B2; U.S. Patent Application Publication Nos. US 2002/0103278 A1 and US 2003/0064256 A1; PCT Published Patent Application Nos. WO 96140811 A1 and WO 98/29489 A1; and Sulfated and tungstated zirconium-solid,

strong acid catalysts, MELCat Doc 2000, (MEL Chemicals/MEI/Nikkei-MEL), available on the Internet at <http://www.zrchem.com/literature/literature/PDF%27s/MEL2000.pdf>

[0006] References relating to multilayer floor finishes include U.S. Pat. No. 5,851,618, U.S. Patent Application Publication No. US 2002/0028621A1 and PCT Published Application No. WO 98/11168. Commercial multilayer coatings JIB Hart Coatings, Inc.'s HP Products line of polyurethane and epoxy primers and coatings, and Minute-man International, Inc.'s FIRST ROUND™ undercoat, FINAL FLOOR™ topcoat and aziridine crosslinker/catalyst Various multilayer vehicular priming and paint systems are described in U.S. Pat. Nos. 4,917,955, 5,225,248, 5,573,812, 5,578,345 and 5,580,610.

SUMMARY OF THE INVENTION

[0007] Due to their relatively long tack-free times, multiple-component polyurethane coatings can be difficult to apply to flooring. Following application of the polyurethane coating, the floor cannot be put into service until the hardening process has advanced sufficiently so that the floor can withstand foot traffic. Sometimes it is necessary to apply more than one layer of polyurethane coating in order to obtain sufficient film thickness and durability. In such cases the polyurethane coating cannot be recoated until the hardening process has advanced sufficiently so that the floor can be walked upon to apply the second or subsequent layers. While hardening of the various layers takes place, the floor is out of service and the finish is susceptible to damage. Catalysts such as dibutyltin dilaurate can sometimes be employed to reduce coating tack-free times, but this may also undesirably increase cost owing to dibutyltin dilaurate's relatively high price. Zinc-containing catalysts may also be employed. However, regulations may limit the use of catalysts based on tin or zinc.

[0008] We have found that zirconium carbonates can be used to initiate rapid hardening of multicomponent polyurethanes. The hardening effect appears to be generally as rapid as that obtained using dibutyltin dilaurate. When added in an appropriate amount, zirconium carbonates can substantially decrease the coating tack-free time without unduly shortening pot life. Zirconium carbonates can also initiate hardening of a multicomponent polyurethane coating when present in an adjacent non-polyurethane layer, whereas dibutyltin dilaurate does not appear to provide such an effect.

[0009] The present invention provides in one aspect an autohardenable polyurethane coating comprising sufficient zirconium carbonate to decrease the coating tack-free time.

[0010] In another aspect the invention provides a method for applying a polyurethane finish comprising applying to a substrate a layer of an autohardenable polyurethane coating comprising sufficient zirconium carbonate to decrease the coating tack-free time.

[0011] The invention also provides a jobsite-renewable point of use floor finish system comprising a substantially isocyanate-free undercoat, an autohardenable polyurethane topcoat and instructions for jobsite application of the undercoat to a floor and the topcoat to the undercoat, wherein the undercoat or topcoat contain sufficient zirconium carbonate to decrease the topcoat tack-free time.

[0012] The invention provides in another aspect a method for applying a jobsite-renewable finish to a floor comprising

applying to the floor a multilayer coating system comprising a layer or layers of a substantially isocyanate-free undercoat and a layer or layers of an autohardenable polyurethane topcoat, wherein the undercoat or topcoat contain sufficient zirconium carbonate to decrease the topcoat tack-free time.

BRIEF DESCRIPTION OF THE DRAWING

[0013] FIG. 1 shows a side view of coated floorboards.

[0014] FIG. 2 shows a side view of coated vinyl floor tiles.

DETAILED DESCRIPTION

[0015] By using words of orientation such as “atop”, “beneath”, “on”, “under”, “uppermost”, “lowermost”, “between” and the like for the location of various layers in the disclosed multilayer coating system, we refer to the relative position of one or more layers with respect to another or where the context requires with respect to an underlying flooring substrate. We do not intend that the layers or flooring substrate must be horizontal, do not intend that the layers and flooring substrate must be contiguous or continuous, and do not exclude the presence of one or more intervening layers between layers or between the flooring substrate and a layer.

[0016] As used in connection with this disclosure, a “multilayer coating system” is a coating system that employs an undercoat and a topcoat of different compositions. In the interest of brevity, a layer or plurality of layers of the undercoat composition located between the flooring substrate and a topcoat may be referred to collectively as an “undercoat”, a layer or plurality of layers of the topcoat composition located atop the flooring substrate and undercoat may be referred to collectively as the “topcoat”, and a combination of a cured undercoat and topcoat (or a topcoat alone) located atop a flooring substrate may be referred to as a “coating” or “finish”.

[0017] As used in connection with this disclosure, a “film-former” is a monomer, oligomer or polymer that can be applied (if need be, with a suitable plasticizer or coalescing solvent) and dried, crosslinked or otherwise hardened to form a tack-free substantially durable film.

[0018] As used in connection with this disclosure, a “hardening system” is a chemical or physical process (including solvent evaporation or other drying processes, photochemical reactions, electrochemical reactions, radical processes, ionic processes, moisture cure processes and multiple-component (e.g., two or three component) crosslinking processes) through which an undercoat or topcoat composition becomes dried, crosslinked or otherwise cured to form a tack-free substantially durable film.

[0019] As used in connection with this disclosure, an “initiator” is an agent that can cause undercoat or topcoat hardening or accelerate the rate at which undercoat or topcoat hardening occurs. We include among initiators materials such as catalysts (including energy activated catalysts, photocatalysts or photoinitiators and thermal catalysts), Lewis and Brønsted acids and bases, radical sources, metal compounds and the like.

[0020] As used in connection with this disclosure, an “autohardenable” polyurethane is a coating that contains a polyol or polyamine and a polyisocyanate, and which begins

hardening upon being mixed or dispensed and without requiring an external energy source such as UV or visible light illumination or elevated heating to harden to at least a tack-free state when in a thin film form. We include among autohardenable polyurethanes those having multi-part (e.g., two-part) formulations with two or more separately packaged polyurethane precursors (typically a polyol or polyamine first component and a polyisocyanate second component) that will harden shortly after the precursors are mixed and applied to a flooring substrate. We also include among autohardenable polyurethanes those whose precursors are packaged in a single container having one or more septa or other suitable dividers that can prevent the precursors from mixing until desired by a user. We also include among autohardenable polyurethanes those containing an encapsulated ingredient that will cause hardening of the polyurethane when the polyurethane is mixed, dispensed or otherwise processed in a way that causes the microcapsules to rupture.

[0021] As used in connection with this disclosure, “pot life” is the time period after an autohardenable polyurethane is dispensed from its container (and if need be, its precursors mixed, dispensed or otherwise processed to initiate hardening) during which the dispensed material can successfully be applied to a flooring substrate to form a thin, visibly smooth, self-leveling, cured film whose properties are generally similar to those exhibited by the polyurethane if applied immediately after being dispensed.

[0022] As used in connection with this disclosure, a polyurethane is regarded as being “stripper-permeable” if when coated atop a desired flooring substrate (and optional intervening undercoat) and subjected to the action of a suitable chemical stripper, the stripper permeates or otherwise penetrates the polyurethane sufficiently so that the polyurethane (and undercoat, if present) can be removed from the floor. Stripper permeability can sometimes be enhanced by mechanically roughening, puncturing or abrading the polyurethane (using, for example, a nonwoven floor scrub pad, brush or other mild abrasive measure) just prior to stripping. A polyurethane will be regarded as being stripper-permeable even if such mechanical roughening is necessary for stripping, so long as such mechanical roughening does not unduly damage the underlying floor.

[0023] As used in connection with this disclosure, a hardened coating is regarded as being “jobsite-renewable” if, at such time as it may be desired to do so, the coating can be removed from an underlying flooring substrate without removing substantial portions of the flooring substrate, using simple, minimally abrasive measures such as a methylene chloride-free or acetone-free chemical stripper and a mop and detergent solution, mildly abrasive but flooring-safe measures such as a nonwoven floor scrub pad, or other measures such as peeling (and without requiring aggressive removal techniques such as grinding, sanding, sandblasting or a stripper based on methylene chloride or acetone), and then replaced with the same or a substantially similar finish and hardened to provide a visibly smooth tack free substantially durable film.

[0024] As used in connection with this disclosure, an “oligomer” is a polymerizable (e.g., crosslinkable) moiety containing a plurality (e.g., 2 to about 30) of monomer units.

[0025] FIG. 1 shows an end view of multipiece flooring material 10 comprising floorboards 11 made of wood, wood

fibers, a composite or other suitably durable material. Each floorboard **11** has a top surface **12**, side surfaces **13** and **14**, and additional side or end surfaces that are not shown in **FIG. 1**. Fasteners **15** (shown in phantom in **FIG. 1**) hold floorboards **11** in place on underlayment **16** and subfloor **17**. Undercoat **18** coats the top surfaces **12**, and fills and seals at least the uppermost portions of the gaps **19** between each floorboard **11**. Topcoat **20** lies atop undercoat **18**. Following installation of flooring material **10**, the tops **12** of floorboards **11** can be sanded so that they are coplanar before topcoat **18** is applied to fill and seal the gaps **19** between floorboards **11**. This enables flooring material **10** to have a better appearance and easier cleanability than would be the case if a topcoat had been factory-applied prior to installation of the flooring material. In a multipiece floor made from floorboards whose finish has been factory-applied, there can be small differences in height between adjacent floorboards. This arises because the floorboards cannot be sanded after installation sufficiently to make the tops of the floorboards coplanar without potentially also removing at least some of the factory-applied finish. In such a floor, small gaps between adjacent floorboards typically are not filled or sealed by the factory-applied finish.

[0026] **FIG. 2** shows an end view of multipiece flooring material **25** comprising vinyl composite tiles **26**. Each tile **26** has a top surface **27**, side surfaces **28** and **29**, and additional side or end surfaces that are not shown in **FIG. 1**. Adhesive **30** holds tiles **26** in place on underlayment **31** and subfloor **32**. Finish **34** includes undercoat **35** atop the tiles **26** and a slipper-permeable topcoat **36** atop undercoat **35**. Undercoat **35** coats the top surfaces **27**, and fills and seals at least the uppermost portions of the gap **37** between each tile **26**.

[0027] As used in connection with this disclosure, the term "zirconium carbonates" refers to salts (including mixed or complex salts) that theoretically contain zirconium carbonate. Suitable zirconium carbonates include sodium zirconium carbonate, potassium zirconium carbonate and ammonium zirconium carbonate. Representative commercially available zirconium carbonates include KZCOTE™ 5000 potassium zirconium carbonate, AZCOTE™ 5800M, AZCOTE 5800L and AZCOTE 5880IN ammonium zirconium carbonate (all available from Eka Chemicals); PEKONEL PZC potassium zirconium carbonate (available from Clariant Corp.) and BACOTE™ 20 ammonium zirconium carbonate and ZIRMEL™ 1000 potassium zirconium carbonate (both available from MEI/MEL Chemicals/Nikkei-MEL). Preferred zirconium carbonates are water-soluble or water-dispersible. Potassium zirconium carbonate and ammonium zirconium carbonate are both commercially available in water solutions and are preferred for use in waterborne undercoats or topcoats.

[0028] Sufficient zirconium carbonate should be employed in the polyurethane coating (or in an adjacent layer of a substantially isocyanate-free coating) so that the polyurethane tack-free time decreases. Preferably the tack-free time decreases by at least about 10%, more preferably by at least about 30% and most preferably by at least about 50% compared to a polyurethane coating prepared without any zirconium carbonate or other initiator in the coating (or in an adjacent coating) and evaluated using the cotton ball Tack-Free Evaluation method described below. If present in the polyurethane, the zirconium carbonate concentration preferably is sufficiently low so that the polyurethane has a pot

life of at least about 20 minutes, more preferably at least about 30 minutes, and yet more preferably at least about 1 to about 2 hours. As a general numeric guide, when a zirconium carbonate is added to the topcoat, the topcoat preferably contains about 0.01 to about 15 wt. % zirconium carbonate, and more preferably about 0.1 to about 10 wt. % based on the zirconium carbonate weight compared to the total topcoat dry weight. When used in an adjacent substantially isocyanate-free coating (e.g., an undercoat in the case of a multilayer floor finish composition), the adjacent layer preferably contains about 1 to about 95 wt. % zirconium carbonate, more preferably about 5 to about 90 wt. %, and most preferably about 10 to about 85 wt. % based on the zirconium carbonate weight compared to the total undercoat dry weight. The zirconium carbonate may also be applied by itself underneath a topcoat, and used to initiate topcoat cure even though not initially part of an autohardenable polyurethane layer. When part of the same autohardenable layer, a polyurethane and the zirconium carbonate preferably are combined using stirring or other methods that will be apparent to those skilled in the art. If added as an aqueous solution or dispersion to a multicomponent polyurethane, the zirconium carbonate preferably is added to the polyol or polyamine precursor rather than to a polyisocyanate precursor to prevent premature reaction. If added in an appropriate organic solvent, the zirconium carbonate can be added to the polyisocyanate precursor if desired. The addition can take place well prior to or at a job site.

[0029] A variety of polyurethane precursors can be employed in the invention. The precursors as mixed or dispensed may be solvent-borne, waterborne or 100% solids, and may represent a multipart (e.g., a two component or 2K) composition or a latent one part composition containing a blocked isocyanate and, if desired, a suitably encapsulated zirconium carbonate. The polyurethane precursors preferably are water-soluble or water-dispersible. Water solubility or water dispersibility can be facilitated in a variety of ways that will be familiar to those skilled in the art, including incorporating appropriate functional groups in the polyurethane precursors, converting one or more of the polyurethane precursors to their salt forms, or adding a suitable cosolvent or surfactant. Preferred polyurethane formulations include those employing a (i) polyol such as a polyester polyol, polyether polyol, acrylic polyol or combination thereof and (ii) a polyisocyanate such as an aliphatic or aromatic isocyanate oligomer. Two component waterborne polyurethane formulations are especially preferred. As a general guide, the water concentration preferably is from about 15 to about 85 wt. % based on the polyurethane weight. More preferably, the polyurethane contains about 25 to about 75 wt. % water, and most preferably about 35 to about 70 wt. % water. The polyurethane may also contain a suitable diluent, solvent, plasticizer or cosolvent, at a concentration which may vary depending in part on the other polyurethane ingredients and on the intended application and application conditions. As a general guide, the diluent, solvent, plasticizer or cosolvent concentration preferably is from 0.1 to about 10 wt. % based on the polyurethane solution weight, and more preferably about 1 to about 7 wt. %.

[0030] Representative waterborne polyurethanes are described in U.S. Pat. Nos. 6,316,535 B1 and 6,544,942 B1 and in U.S. Patent Application Publication No. US 2002/0028621 A1. Suitable commercially or experimentally avail-

able two-part waterborne polyurethanes include those from suppliers including Air Products and Chemicals, Inc. (e.g., No. AD200C1 polyester polyurethane formulation), Bayer AG (e.g., No. MG98-040 polyester polyurethane formulation), Dow Plastics (e.g., VORANOL™ diols and tools), Reichhold, Inc. (e.g., No. STAY-CLAD™ 5900 hydroxyl-functional acrylic polymer dispersion and No. 3955-24W acrylic polyurethane formulation), Cognis Corporation (e.g., G-CURE™ Resins such as G-CURE 105P70 acrylic resin or G-CURE 108 acrylic resin), Lyondell Chemical Company (e.g., ACRYFLOW™ P60 or ACRYFLOW P90 acrylic polyol resins), U.S. Polymers, Inc. (e.g., Nos. 979-1 and 980-3 polyester polyurethane formulations) and Zeneca Resins (e.g., No. G-2029 acrylic polyurethane formulation).

[0031] The polyurethane can contain a variety of adjuvants to alter its performance or properties before or after application to a floor. Useful adjuvants include hardening retarders (which function as pot life extenders); pigments, fillers and other inorganic or organic (e.g., polymeric) particles; flattening agents; antimicrobial agents; corrosion inhibitors; surfactants; surface slip modifiers; defoamers; waxes; indicators; UV absorbers; light stabilizers; antioxidants; plasticizers; coalescents and adhesion promoters. The types and amounts of such adjuvants will be apparent to those skilled in the art. The polyurethane may if desired be a pigmented coating or paint. The polyurethane can also contain a lightening agent (described farther in application Ser. No. 10/843,014 entitled FLOOR FINISH WITH LIGHTENING AGENT, filed May 11, 2004, the disclosure of which is incorporated herein by reference).

[0032] The polyurethane may contain inorganic or organic particles (or both inorganic and organic particles) to enhance its abrasion resistance, scratch resistance, wear resistance or strippability. Preferred inorganic particles are described in copending U.S. patent application Ser. No. 09/657,420 filed Sep. 8, 2000 and entitled SCRATCH-RESISTANT STRIPPABLE FINISH, the disclosure of which is incorporated herein by reference. Representative inorganic particles include silicas such as filmed silicas, stabilized silica sols, silica organosols, silicon dioxide particles, colloidal silicas and spherical silicas; aluminas such as aluminum oxide particles and alumina modified colloidal silica; and glasses such as glass beads and glass microbubbles. Representative organic particles include EXPANCEL™ spherical plastic microspheres, commercially available from Akzo Nobel N.V., HYDROPEL™ QB organic particles and NON-SKID™ modified polypropylene waxes, both commercially available from Shamrock Technologies, Inc. Although the inorganic or organic particles may if desired be obtained in dry powder form, preferably they are employed in aqueous or solvent-based dispersions, as such dispersions are much more easily combined with the polyurethane in general, solvent-based particle dispersions can easily be combined with waterborne polyurethanes and generally can provide good gloss and good film integrity in the cured coating. However, solvent-based particle dispersions tend to be more expensive than aqueous particle dispersions. When waterborne particle dispersions are combined with waterborne polyurethanes, the resulting coating may have somewhat lower gloss and film integrity. We prefer in such circumstances to combine a waterborne particle dispersion with a suitable dispersing solvent (e.g., alcohols such as methanol, ethanol or isopropyl alcohol) that will dissolve in or be miscible with both water and the polyurethane, and that will

help to disperse the particles in the polyurethane. The resulting mixture of waterborne particles and dispersing solvent can be combined with the polyurethane and mixed using a suitable mixing device such as a sonic mixer.

[0033] Suitable inorganic and organic particles are available in a wide variety of average particle diameters. Small diameter particles tend to provide better adhesion of the polyurethane to an undercoat layer (if present), but also tend to be more expensive than large diameter particles. Large particles may provide better surface scratch resistance. Preferably, the average particle diameter is about 3 to about 10,000 nanometers, more preferably about 12 to about 7,500 nanometers. In some cases, use of a bimodal mixture of small and large diameter particles can provide a cured finish having an optimal balance of good coating properties, scratch resistance and durability. The polyurethane preferably contains sufficient inorganic or organic (or both inorganic and organic) particles to provide increased scratch resistance compared to a polyurethane that does not contain such particles. If desired, large amounts of inorganic or organic particles can be employed, so long as the other properties of the polyurethane are not unduly harmed by the thickening effect or loss of gloss caused by the particle addition. However, particle additions in relatively small amounts may provide a significant improvement in scratch resistance. Preferably, the polyurethane contains about 1 to about 50 wt. % inorganic or organic particles based on the weight of polymerizable solids in the polyurethane. More preferably, the polyurethane contains about 1 to about 25 wt. % inorganic or organic particles, and most preferably about 1 to about 10 wt. % inorganic or organic particles.

[0034] A variety of undercoat compositions can be employed in multilayer polyurethane compositions applied to flooring substrates. Preferred undercoats are film-formers that will adhere to the floor, provide an adherent surface for the polyurethane, and be removable using stripping or peeling. Most preferably the undercoat will be strippable using a chemical stripper that is capable of permeating, dissolving, swelling or otherwise softening the polyurethane sufficiently so that the agent can act upon the undercoat. Thus the choice of undercoat may be determined in part by the chosen polyurethane and stripper. The undercoat desirably should be more strippable than the polyurethane. The undercoat can be solvent-borne, waterborne or 100% solids, and can employ a variety of hardening systems. Water-soluble or water dispersible (as is or with a dispersing agent) acid-containing polymers crosslinked using transition metals (e.g., zinc crosslinked acrylics), alkaline earth metals, alkali metals or mixture thereof are a particularly preferred class of undercoats and a particularly preferred hardening system. These polymers preferably can be stripped using a variety of strippers that dissolve the undercoat or attack its crosslinking site. Other film-forming materials such as zinc-free acrylic finishes (e.g., acrylic copolymers), water-based (e.g., waterborne) latex emulsions, polyvinyl acetate copolymers (e.g., polyvinyl acetate-polyethylene copolymers), polyvinyl alcohol and its copolymers, polyvinylpyrrolidone and its copolymers, modified cellulose, sulfonated polystyrenes and a variety of other materials that will be familiar to those skilled in the art (e.g., film forming water-soluble or water-dispersible polymers other than those already mentioned) can also be employed as undercoats. The undercoat can if desired be applied in several layers containing different materials in each layer. The individual layers need not be

homogeneous. For example, the zirconium carbonate may be desired bloom to the surface of the hardened undercoat.

[0035] When zirconium carbonate is added only to an undercoat layer, improved topcoat coating quality may be observed if an undercoat layer containing the zirconium carbonate is overcoated, before the topcoat is applied, with an unmodified undercoat layer that does not contain zirconium carbonate. We have observed a reduction in topcoat tack-free time even when such an intervening unmodified undercoat layer is employed in a multilayer floor finish, and have observed smoother topcoat coating results when doing so.

[0036] The undercoat may if desired contain other initiators for the polyurethane hardening system in place of or in addition to the zirconium carbonate. For brevity the zirconium carbonate and other such initiators can be collectively referred to as "topcoat initiators". Preferably the topcoat initiator is not an initiator for the undercoat hardening system. Exemplary topcoat initiators include tin compounds such as dibutyl tin dilaurate, stannous octoate and FASCAT™ 4224 dibutyltin bis(1-thioglycerol) catalyst (commercially available from ATOFINA Chemicals, Inc.); amines; and zinc compounds such as zinc crosslinked acrylic dispersions (described further in application Ser. No. 10/755,972 entitled AQUEOUS POLYURETHANE COATING SYSTEM CONTAINING ZINC CROSSLINKED ACRYLIC DISPERSION, filed Jan. 12, 2004, the disclosure of which is incorporated herein by reference) and zinc carbonates including zinc tetraacetate carbonate and zinc ammonium carbonate (described further in application Ser. No. 10/755,976 entitled POLYURETHANE COATING CURE ENHANCEMENT USING ZINC CARBONATE INITIATORS, filed Jan. 12, 2004, the disclosure of which is incorporated herein by reference).

[0037] The undercoat preferably contains water or another suitable diluent, plasticizer or coalescent, including compounds such as benzyloxyethanol; an ether or hydroxyether such as ethylene glycol phenyl ether (commercially available as "DOWANOL EPh" from Dow Chemical Co.) or propylene glycol phenyl ether (commercially available as "DOWANOL PPh" from Dow Chemical Co.); dibasic esters such as dimethyl adipate, dimethyl succinate, dimethyl glutarate, dimethyl malonate, diethyl adipate, diethyl succinate, diethyl glutarate, dibutyl succinate, and dibutyl glutarate (including products available under the trade designations DBE, DBE-3, DBE-4, DBE-5, DBE6, DBE-9, DBE-IB, and DBE-ME from DuPont Nylon); dialkyl carbonates such as dimethyl carbonate, diethyl carbonate, dipropyl carbonate, diisopropyl carbonate, and dibutyl carbonate; phthalate esters such as dibutyl phthalate, diethylhexyl phthalate, and diethyl phthalate; and mixtures thereof. Cosolvents can also be added if desired to assist in formulating and applying the undercoat. Suitable cosolvents include Butoxyethyl PROPASOL™, Butyl CARBITOL™ acetate, Butyl CARBITOL™, Butyl CELLOSOLVE™ acetate, Butyl CELLOSOLVE™, Butyl DIPROPASOL™, Butyl PROPASOL™, CARBITOL™ PM-600, CARBITOL™ Low Gravity, CELLOSOLVE™ acetate, CELLOSOLVE™, Ester EEP™, FILMER IBT™, Hexyl CARBITOL™, Hexyl CELLOSOLVE™, Methyl CARBITOL™, Methyl CELLOSOLVE™ acetate, Methyl CELLOSOLVE™, Methyl DIPROPASOL™, Methyl PROPASOL™ acetate, Methyl PROPASOL™, Propyl CARBI-

TOL™, Propyl CELLOSOLVE™, Propyl DIPROPASOL™ and Propyl PROPASOL™, all of which are available from Union Carbide Corp.; and mixtures thereof. The concentration may vary depending in part on the other undercoat ingredients and on the intended application and application conditions. As a general guide, when water alone is used as a diluent, the water concentration preferably is from about 15 to about 98 wt. % based on the undercoat solution weight. More preferably, the undercoat contains about 25 to about 95 wt. % water, and most preferably about 60 to about 95 wt. % water. If a diluent, plasticizer, coalescent or cosolvent other than water is included in the undercoat solution, then its concentration preferably is from about 0.1 to about 10 wt. % based on the weight of polymerizable solids in the undercoat, and more preferably about 1 to about 7 wt. %

[0038] The undercoat can contain a variety of adjuvants to alter its performance or properties before or after application to a floor. Useful adjuvants include those mentioned above in connection with the polyurethane.

[0039] Often it will be convenient to prepare the undercoat by adding zirconium carbonate to a commercially available floor finish material such as FRONT COURT™, GEMSTAR LASER™, GEMSTAR POLARIS™, ORION™ base coat, PADLOCK™, RIVET™ and TAJ MAHAL™ acrylic floor finishes, COUR MASTER II™ urethane floor finish and ISI STAR™, ISI CLEAN™ and TUKLAR MEDICAL™ floor finishes from Ecolab Inc.; CORNERSTONE™ and TOPLINE™ acrylic floor finishes from 3M; HIGH NOON™ acrylic finish from Butchers; CITATION™ acrylic finish from Buckeye International, Inc.; COMPLETE™, SIGNATURE™, TECHNIQUE™ and VECTRA™ acrylic floor finishes from SC Johnson Professional Products; SPLENDOR™, DECADE 90™, PRIME SHINE™ ULTRA and PREMIER™ acrylic finishes and FIRST ROUND and FORTRESS™ urethane acrylic finishes from Minuteman, International, Inc.; FLOORSTAR™ Premium 25 floor finish from ServiceMaster, Inc; UPPER LIMITS™ acrylic finish from Spartan Chemical Co.; and materials such as those described in U.S. Pat. Nos. 4,517,330 and 5,319,018 and the patents cited therein Strippable floor coatings designated as "sealers" (e.g., OVER AND UNDER™ floor sealer from SC Johnson Professional Products and ACRYL-KOTE™ Seal and Finish and PREP Floor Seal from Minuteman, International, Inc.), strippable coatings based on polyvinylacetates and blends of any of the foregoing may also be employed as undercoats. Polymer emulsions such as DURAPLUS™ 3 zinc crosslinked acrylic dispersion, used as an ingredient in some floor finishes and commercially available from Rohm & Haas Co., and ROSHIELD™ 3120 UV curable acrylate coating from Rohm & Haas Co. (taken alone or blended with styrene maleic anhydride polymer as described in PCT Published Patent Application No. 98/11168) may also be employed as undercoats. If desired, two or more layers of different undercoats can be employed in order to optimize properties such as adhesion to the floor or to the topcoat, wear resistance, strippability, etc.

[0040] The polyurethane coatings can be applied to a variety of substrates, including wood, plastics, metals, concrete, wallboard and other mechanical or architectural substrates. The disclosed coatings are particularly well-suited for application to flooring substrates due to their shortened tack-free times. This permits an applicator to walk on the flooring substrate relatively soon after coating application in

order to apply additional layers of the composition or to return the floor to service. Representative flooring substrates include resilient substrates such as sheet goods (e.g., vinyl flooring, linoleum or rubber sheeting), vinyl composite tiles, rubber tiles, cork and synthetic sports floors, and non-resilient substrates such as concrete, stone, marble, wood, ceramic tile, grout and Terrazzo. The coating can be jobsite-applied to a flooring substrate after the substrate has been installed (e.g., to monolithic flooring substrates such as sheet vinyl goods, linoleum, cork, rubber sheeting, synthetic sports floors, concrete, stone, marble, grout or Terrazzo, or to multipiece flooring substrates such as vinyl composite tiles, wood floorboards, porcelain tiles, clay tiles, ceramic tiles or bamboo), or can be factory-applied to a flooring substrate before it is installed (e.g., to monolithic flooring substrates such as sheet vinyl goods in roll form, or multipiece flooring substrates such as vinyl composite tiles or wood floorboards). Jobsite application is especially preferred, with suitable jobsites including indoor and outdoor sites involving new or existing residential, commercial and government- or agency-owned facilities.

[0041] The polyurethane coatings can be applied using a variety of methods, including spraying, brushing, flat or string mopping, roll coating and flood coating. Mop (e.g., string or flat mop) or roller application is preferred for coating most floors. Suitable mops include those described in U.S. Pat. Nos. 5,315,734, 5,390,390, 5,680,667 and 5,887,311. Typically, the floor should first be cleaned and any loose debris removed. One or more undercoat layers or coats (diluted if necessary with water or another suitable diluent or cosolvent) may be applied to the floor. One to three undercoat layers typically will be preferred. When multiple undercoat layers are employed they can be the same or different. Each undercoat layer preferably will have a dry coating thickness of about 2.5 to about 25 μm , more preferably about 2.5 to about 15 μm . Preferably the overall undercoat dry coating thickness will be about 5 to about 100 μm , and more preferably about 5 to about 50 μm .

[0042] After the undercoat has hardened sufficiently so that its visual and physical properties have developed and it is safe to apply a polyurethane layer (or if no undercoat is employed, after the cleaned floor has dried), the polyurethane can be applied. The degree of undercoat hardening that will be deemed sufficient for such polyurethane application and the associated waiting period will usually vary depending on factors such as the undercoat and polyurethane formulations, undercoat coating thickness, ambient conditions and polyurethane coating method, and typically may involve a wait of about 15 minutes to about one hour before polyurethane application. Full hardening of the undercoat may not be needed before the polyurethane can safely be applied. In many instances safe application of the polyurethane will be possible once it is possible to walk on the undercoat without marring it.

[0043] One or more (e.g., one to three) polyurethane layers may be applied to the floor or to the undercoat layers. The polyurethane layers preferably are applied before the polyurethane pot life elapses. The presence of an initiator for the polyurethane in the undercoat appears primarily to affect the tack-free time for the first polyurethane layer. If the first polyurethane layer is allowed to harden sufficiently so that it can be walked upon, then the tack-free time for subsequent polyurethane layers may not be greatly influenced by the

presence of the initiator in the undercoat. If such subsequent polyurethane layers are applied before the first polyurethane layer reaches a walk-on state then some reduction in tack-free time may be observed in the subsequent layers. The undercoat may be formulated with a view to promoting the efficacy of the initiator in reducing polyurethane tack-free times. The polyurethane usually is formulated with a view to attaining high durability, a factor that may reduce the efficacy of the initiator with respect to such subsequent polyurethane layers. Each polyurethane layer preferably will have a dry coating thickness of about 2.5 to about 200 μm , more preferably about 5 to about 100 μm . Preferably the overall polyurethane dry coating thickness will be relatively thin in order to reduce raw material costs, e.g., about 2.5 to about 400 μm , and more preferably about 2.5 to about 100 μm . Multilayer finishes preferably will have an overall dry coating thickness of about 10 to about 500 μm , and more preferably about 10 to about 80 μm .

[0044] The floor can be placed into service (or returned to service) once the finish has hardened sufficiently to support normal traffic without marring. Inclusion of zirconium carbonate in the polyurethane topcoat (or if used, in the undercoat) promotes faster topcoat cure and enables the floor to be subjected to normal traffic much earlier than if the initiator is not employed.

[0045] The finish can receive normal maintenance until such time as it is desired to remove and renew it. Removal can be carried out, for example, by cleaning the floor (using e.g., a brush or mop) followed by application of a stripper. The chosen stripper may depend in part on the chosen undercoat and polyurethane. Preferred strippers include compositions containing phenyl alcohols (e.g., benzyl alcohol); alkoxy ethers (e.g., glycol ethers such as propylene glycol methyl ether and ETHYL CARBITOL™, BUTYL CARBITOL™ and BUTYL CELLOSOLVE™ solvents from Union Carbide Corp.); alkoxy esters; aryloxy alcohols (e.g., phenoxy ethanol and phenoxy propanol); dibasic esters; N-alkyl pyrrolidones, ketones, esters, metasilicates; amines (e.g., ethanolamine); alkanolamines (e.g., monoethanolamine); acid based agents and caustic agents (e.g., sodium or potassium hydroxide). Strippers containing phenyl alcohols are especially preferred for stripping multilayer finishes employing polyurethane topcoats owing to the relatively high rate at which phenyl alcohols may penetrate such topcoats and their ease of use and low odor. A particularly preferred stripper concentrate contains a polar solvent that is denser than water and a sufficiently low level of cosolvent or surfactant so that upon mixing with water a pseudo-stable aqueous dispersion forms which will phase-separate following application to a surface. Concentrates of this type are described in U.S. Pat. No. 6,544,942. Another preferred stripper concentrate contains about 1 to 75 wt. percent of an ether alcohol solvent having a solubility in water of less than about 5 wt. % of the solvent, and about 1 to 75 wt. % of an ether alcohol solvent/coupler having a solubility in water of about 20 to about 100 wt % of the solvent/coupler, wherein the vapor pressure of the concentrate is less than 1 millimeter Hg. Concentrates of this type are described in U.S. Pat. No. 6,583,101. The stripper can contain a variety of

adjuvants to alter the performance or properties of the stripper before or after application to a cured polyurethane finish. Useful adjuvants include abrasive particles, surfactants, defoamers, indicators, slip reducing agents, colorants and disinfectants. The types and amounts of such adjuvants will be apparent to those skilled in the art.

[0046] The stripper should be allowed to stand for a suitable time (e.g., for a minute or more, preferably for two hours or less, and most preferably for between about 5 minutes and about 1 hour) while it softens the finish. After the finish softens sufficiently it can be removed using a variety of techniques including scrubbing, vacuuming, mopping, use of a squeegee, scraping, sweeping, wiping, mild abrasion or other measures that do not remove substantial portions of the floor. Removal will usually be made easier if water or a suitable detergent solution is applied to the softened finish. The floor can be allowed to dry and new layers of the undercoat and polyurethane applied to renew the finish.

[0047] Multilayer finishes typically will be sold in the form of a kit that is ready to apply at the point of use. A typical such point of use floor finish system will include the undercoat and polyurethane in suitable containers or dispensers together with suitable instructions for mixing or dispensing any undercoat and polyurethane components as needed and for applying the undercoat atop a floor and applying the polyurethane atop the undercoat. If desired, the undercoat or polyurethane could be packaged as concentrates intended to be mixed with water or another suitable solvent prior to application. Optionally the kit may include a stripper concentrate in a suitable container. The stripper concentrate typically will be mixed with water or another suitable carrier at, for example, about 5-30% by weight active ingredients prior to application. The kit can also contain additional undercoat materials (e.g., leveling coatings) that can be applied to the floor before application of the undercoat and polyurethane, or various additional materials (e.g., maintenance coats or wax finishes) that can be applied atop the polyurethane. Maintenance coats typically will be applied when the initially-applied multilayer coating exhibits noticeable wear or loss of gloss, and typically will be applied at solids levels that are the same as or somewhat less than the solids levels of the initially-applied polyurethane.

[0048] If desired, the multilayer floor finishes can also be factory-applied to a variety of flooring substrates. For example, when factory-applied to a multipiece flooring material, the pieces typically will be coated on at least the top surface and optionally coated or partially coated on the side or bottom surfaces.

[0049] The invention is further illustrated in the following non-limiting examples, in which all parts and percentages are by weight (wt.) unless otherwise indicated.

Tile Preparation

[0050] Industrial black and white 305 mm×305 mm vinyl composition tiles (commercially available from the Congoleum Corporation) were used in all examples. Before use, the tile surfaces were cleaned and roughened until no longer shiny, by rubbing with MAGICSCRUB™ mild abrasive cleaner (commercially available from Ecolab Inc) using a

non-woven SCOTCH-BRITE™ green abrasive scrub pad (commercially available from 3M Company). The cleaned tiles were rinsed with tap water and dried at room temperature. This removed all factory applied coatings and surface soil, and provided a consistently reproducible surface.

Undercoat Formulations and Coating Method

[0051] A single coat of PADLOCK™ metal crosslinked acrylic polymer-based floor finish (commercially available from Ecolab Inc.) was applied to the clean tiles using commercially available microfiber pads and a wet coating rate of about 48 m²/liter. For examples employing an undercoat containing zinc carbonate, a first undercoat layer of unmodified PADLOCK finish was overcoated with a second undercoat layer of modified PADLOCK finish to which had been added potassium zirconium carbonate solution. The first undercoat layer (and where used, the second undercoat layer) were allowed to air dry for at least 45 minutes before applying any overcoat layers. As noted above, the order of application of unmodified and modified undercoat layers could be reversed, with the modified undercoat layer being applied first followed by an unmodified undercoat layer.

Topcoat Formulations and Coating Method

[0052] The coated tiles were evenly divided into four sections. Two-component polyurethane topcoat formulations based on commercially available polyester polyol resins and commercially available hexamethylene diisocyanates were prepared as follows. The polyester polyol precursor (designated as Part A in Table A, shown below) was made by mixing the ingredients in the order indicated, with mixing as needed along the way to ensure good ingredient dispersion.

[0053] For Topcoat No. 1, the topcoat initiator was mixed directly into Part A. Part A was then combined with the isocyanate (designated Part as B in Table A) according to the weight ratios given in Table A and mixed vigorously for three minutes.

[0054] For Topcoat No. 2 through Topcoat No. 6, Part A and Part B were mixed vigorously for three minutes. The topcoat initiator was next premixed with 2.73 parts deionized water and added to the mixture of Part A and Part B, and mixed for a farther 30 seconds to one minute.

[0055] At 10 minutes after the addition of Part A to Part B (in the case of Topcoat No. 1) or at 5 minutes after the addition of Part A to Part B (in the case of Topcoat No 2 through Topcoat No. 6), the mixture viscosity was measured and about 1.6 to 1.8 g of the topcoat was coated on one quarter of the tile (atop the air-dried undercoat, if present) using a flocked pad. In some instances, about 1.6 to 1.8 g of the topcoat was coated on additional quarters of the tile using the same flocked pad at intervals of about 30 minutes, 45 minutes and 60 minutes after the start of coating application. This enabled a qualitative evaluation of coating quality and pot life, and the later taking of 20° and 60° gloss measurements for the coated tile quarter corresponding to each coating interval. The topcoated tiles were allowed to dry at room temperature. The dried tiles had a tack-free, glossy finish.

TABLE A

Ingredient	Topcoats					
	Topcoat No. 1	Topcoat No. 2	Topcoat No. 3	Topcoat No. 4	Topcoat No. 5	Topcoat No. 6
	Parts by weight					
Part A						
Polyester polyol ⁽¹⁾		220.6	215.9	31.3	31.3	31.3
Ammonia		0.634	0.5	0.13	0.13	0.13
Defoamer ⁽²⁾		4		0.57	0.57	0.57
Silicone defoamer ⁽³⁾			0.7			
Deionized water		75	244	10.38	10.38	10.38
Solvent ⁽⁴⁾		25				
Defoamer emulsion ⁽⁵⁾		3	5.5			
Wetting agent ⁽⁶⁾		5.7	3.5	0.34	0.34	0.34
Acrylic polymer emulsion ⁽⁷⁾			198.3			
Dipropylene glycol dimethyl ether				3.55	3.55	3.55
Polyester polyol ⁽⁸⁾	88.90			5.0	10.0	15.0
Silicone defoamer ⁽⁹⁾		0.13				
Surface agent ⁽¹⁰⁾		0.06				
Surface agent ⁽¹¹⁾		1.16		0.74	0.74	0.74
Deionized water	9.75	295.7		42.99	42.99	42.99
Part B						
Hexamethylene diisocyanate ⁽¹²⁾	39.78	100	100	100	100	100
Hydrophilic hexamethylene diisocyanate ⁽¹³⁾	100					
Mix Ratios						
Part A	37.5	27.86	27.86	27.86	27.86	27.86
Part B	12.5	9.41	9.41	9.41	9.41	9.41

⁽¹⁾W2K™ 2002, U.S. Polymers, Inc.

⁽²⁾DEEFO™ PI-4, Ultra Additives, Inc.

⁽³⁾BYK™ -020, BYK Chemie.

⁽⁴⁾Propylene glycol 1-monomethyl ether 2-acetate

⁽⁵⁾FOAMEX™ 822, Tego Chemie.

⁽⁶⁾BYK™ -346, BYK Chemie.

⁽⁷⁾LA-7514, U.S. Polymers, Inc.

⁽⁸⁾BAYHYDROL™ XP-7093, 30% nonvolatiles, Bayer Corporation,

⁽⁹⁾BYK™ -025, BYK Chemie.

⁽¹⁰⁾BYK™ -348, BYK Chemie.

⁽¹¹⁾BYK™ -380, BYK Chemie.

⁽¹²⁾DESMODUR™ N-3600, Bayer Corporation.

⁽¹³⁾BAYHYDUR™ XP-7165, Bayer Corporation.

Film Evaluation

[0056] The coated tiles were evaluated to assess tack-free time, solution pot life and gloss, as follows:

Tack-Free Evaluation

[0057] Polyurethane tack-free time was evaluated by placing a small (7.6 mm×7.6 mm) cotton square on the coating surface and covering the cotton square with a 2 kg weight for 30 seconds. The weight was removed and the cotton lightly brushed or rubbed away using a finger. Any substantially noticeable amount of fibers remaining on the topcoat indicated the topcoat was still tacky and that the tack-free time had not been reached- The tack-free time was defined as the interval after which no fibers were retained on the tested coating surface. Coating surfaces that exhibited a shorter tack-free time tended to cure or harden more quickly overall than coatings with longer tack-free times.

Polyurethane Pot Life Evaluation

[0058] Polyurethane pot lives were determined by observing the elapsed time between the start of mixing and the first visual appearance of a precipitate or gel in the polyurethane. The longer it took for precipitation to occur or for a gel to appear, the better the pot life

Gloss

[0059]) Film gloss was measured at 60° and 20° using a Micro-TRI-Gloss meter (commercially available from Paul N. Gardner Co., Inc.). An average of 5 readings was recorded. The standard deviation for individual samples was less than 3 %.

EXAMPLE 1

[0060] Varying amounts of PEKONIL™ PZC potassium zirconium carbonate (commercially available from Clariant as a solution containing about 48-52% solids or approxi-

mately 20 wt. % equivalent zirconium oxide, identified below as "KZrC") were evaluated in the topcoat of a multilayer floor finish system. The undercoat was formed using a single layer of unmodified PADLOCK floor finish applied as described above in the section entitled Undercoat Formulations and Coating Method. The topcoat was formed using Topcoat No. 1, and applied as described above in the section entitled Topcoat Formulations and Coating Method. The weight percent initiator in the topcoat (based on a comparison of the liquid initiator weight to the liquid topcoat weight), polyurethane topcoat pot life, viscosity at the start of coating, tack-free times and initial gloss levels were determined as described above. The results are shown below in Table 1.

TABLE 1

Run No.	Initiator	Wt. % Initiator in Topcoat	Topcoat Pot Life (hours)	Results			
				Initial Topcoat Viscosity, cP	Topcoat Tack-Free Time (hours)	60° Gloss	20° Gloss
1-1	None	0	>1.5	118	8	92.3	85.3
1-2	KZrC	0.075	>1.5	116	7	91.6	82.4
1-3	KZrC	0.413	>1.5	156	6.5	89.8	72.3
1-4	KZrC	0.750	>1.5	174	5	91.5	85.2

[0061] The results in Table 1 demonstrate that a zirconium carbonate could substantially reduce tack-free time when added to a polyurethane topcoat, without unduly harming pot life, initial viscosity or initial gloss.

EXAMPLE 2

[0062] Using the method of Example 1, varying amounts of potassium zirconium carbonate were added to a topcoat (Topcoat No. 7) prepared from the ingredients set out below in Table B. Part A and Part B were mixed vigorously for three minutes. The topcoat initiator was next premixed with 2.73 parts deionized water and added to the mixture of Part A and Part B, following by mixing for a further 30 seconds to one minute.

TABLE B

Ingredient	Parts by weight
Part A	
Polyester polyol ⁽¹⁾	31.23
Ammonia	0.07
Defoamer ⁽²⁾	0.57
Deionized water	10.63
Dipropylenglycol dimethyl ether	3.54
Defoamer emulsion ⁽³⁾	0.43
Silicone defoamer ⁽⁴⁾	0.34
Surface agent ⁽⁵⁾	0.82
Wetting agent ⁽⁶⁾	0.01
Silicone defoamer ⁽⁷⁾	0.01
Deionized water	43.45
Polyester polyol ⁽⁸⁾	8.89
Part B	
Hexamethylene diisocyanate ⁽⁹⁾	100

TABLE B-continued

Ingredient	Parts by weight
Mix Ratios	
Part A	69.65
Part B	23.53

⁽¹⁾W2K™ 2002, U.S. Polymers, Inc.

⁽²⁾DEEFO™ PI-4, Ultra Additives, Inc.

⁽³⁾FOAMEX™ 822, Tego Chemie.

⁽⁴⁾BYK™ -346, BYK Chemie.

⁽⁵⁾BYK™ -380, BYK Chemie.

⁽⁶⁾BYK™ -348, BYK Chemie.

⁽⁷⁾BYK™ -025, BYK Chemie.

⁽⁸⁾BAYHYDROL™ XP-7093, 30% nonvolatiles, Bayer Corporation.

⁽⁹⁾DESMODUR™ N-3600, Bayer Corporation.

[0063] The polyurethane pot life times, viscosity at the start of coating, tack-free times and range of gloss levels observed at the coating intervals (initial, 30 minutes, 45 minutes and 60 minutes after first coating application) described above. The results are shown below in Table 2.

TABLE 2

Run No.	Initiator	Wt. % Initiator in Topcoat	Topcoat Pot Life (hours)	Initial Topcoat Viscosity, cP	Topcoat Tack-Free Time (hours)	Results	
						60° Gloss	20° Gloss
2-1	None	0	>2	308	24	88.5 to 88.8	78.7 to 81.9
2-2	KZrC	0.07	>2	265	13	87.7 to 89	78 to 80.4
2-3	KZrC	0.38	>2	282	9	86.5 to 88.5	72.6 to 77
2-4	KZrC	0.70	>2	440	6.5	87.4 to 89.4	73.2 to 74.3

[0064] The results in Table 2 demonstrate that zirconium carbonate could substantially reduce tack-free time when added to a polyurethane topcoat, without unduly harming pot life or initial viscosity. This formulation exhibited very good 20° and 60° gloss levels that were maintained at higher zirconium carbonate addition levels.

EXAMPLE 3

[0065] PEKONIL PZC potassium zirconium carbonate was added in varying amounts to PADLOCK floor finish, coated in two layers on cleaned tiles with air drying between layers, then overcoated with Topcoat No. 1. The initiator amounts (based on the weight of metal oxide equivalent to the total undercoat solution weight), topcoat tack-free times and 20° gloss values are shown below in Table 3, along with results for a similar multilayer finish made by adding 2% (based on the equivalent weight of zinc oxide) of zinc tetraa ine carbonate (15% zinc (as ZnO), CAS 38714-47-5, low pH version containing about 12-16% ammonia, commercially available from CheinCor and identified by the manufacturer as "zinc ammonium carbonate" and identified below as "ZTC") to Undercoat No. 1.

TABLE 3

Run No.	Initiator	Initiator Cone. In Undercoat, %	Tack-Free time (hours:min)	20° Gloss
3-1	None	0.0	8:20	81
3-2	KZrC	0.7	8:20	81
3-3	KZrC	1.3	6:40	81
3-4	KZrC	2.0	5:20	84
3-5	KZrC	2.7	5:10	79
3-6	KZrC	3.3	5:10	82
3-7	KZrC	4.0	4:10	81
3-8	ZTC	2.0	4:40	81

[0066] The results in Table 3 demonstrate that addition of sufficient potassium zirconium carbonate to the undercoat could substantially decrease the topcoat tack-free time (e.g., by as much as 50% in these runs, compare Run Nos. 6-1 and 6-7), while maintaining good gloss performance. The tack-free time reduction was comparable to that obtained using zinc tetraurate carbonate but the topcoat initiator was zinc-free.

EXAMPLE 4

[0067] Using the general method of Example 2, potassium zirconium carbonate was added at varying levels to Topcoat No. 7 and applied over a single layer of unmodified PAD-LOCK finish. Multilayer floor finishes were also formed by adding zirconium carbonate to a layer of the undercoat (at a level of 11.5% solids in a dried layer of modified PADLOCK floor finish applied atop an unmodified layer, as described above in the section entitled Undercoat Formulations and Coating Method) and overcoated with Topcoat No. 7 containing varying amounts of zirconium carbonate. Set out below in Table 4 are the initiator location, initiator level in the topcoat, polyurethane pot life times, viscosity at the start of coating, tack-free times and initial gloss levels.

TABLE 4

Run No.	Initiator Location (Undercoat/Topcoat)	Wt. % Initiator in Topcoat	Results				
			Topcoat Pot Life (hours)	Initial Topcoat Viscosity, cP	Topcoat Tack-Free Time (hours)	60° Gloss	20° Gloss
4-1	None/Top	0.07	>5	322	9	89.2	80
4-2	Under/Top	0.07	>5	322	6.5	88.9	75.8
4-3	None/Top	0.87	>5	326	7.5	88.8	79
4-4	Under/Top	0.87	>5	326	5.5	89.2	77
4-5	None/Top	1.04	>5	326	8	87.1	75.6
4-6	Under/Top	1.04	>5	326	6	88.8	75
4-7	Under/Top	2.09	>5	444	3.5	89.8	75.4

[0068] The results in Table 4 demonstrate that addition of zirconium carbonate to both the undercoat and topcoat provided a greater reduction in tack-free time than when zirconium carbonate was added only to the topcoat.

EXAMPLE 5

[0069] Using the method of Example 1, varying amounts of PEKONIL™ AZC ammonium zirconium carbonate (commercially available from Clariant as a solution contain-

ing approximately 20 wt. % equivalent zirconium oxide and identified below as "AZrC") or potassium zirconium carbonate were added to 2.73 parts of deionized water, combined with a mixture of Parts A and B of Topcoat No. 2 as described above and coated onto clean tiles. The tack-free times and initial gloss levels were determined as described above. The results are shown below in Table 5. "NM" indicates that the tack-free time was not measured, due to less than optimal observed coating quality.

TABLE 5

Run No.	Initiator	Wt. % Initiator in Topcoat	Results		
			Topcoat Tack-Free Time (hours)	60° Gloss	20° Gloss
5-1	None	0.0	>24	87.2	78.3
5-2	AZrC	0.7	>23	87.2	75.2
5-3	AZrC	2.1	NM	77.6	43.6
5-4	AZrC	3.4	NM	10.4	1.4
5-5	KZrC	0.7	9	86	61.8
5-6	KZrC	2.1	4	83.9	57.1
5-7	KZrC	3.4	NM	47.9	17.2

[0070] The results in Table 5 demonstrate the use of potassium zirconium carbonate and ammonium zirconium carbonate to initiate cure of a polyurethane topcoat

EXAMPLE 6

[0071] Using the method of Example 5, varying amounts of ammonium zirconium carbonate or potassium zirconium carbonate were added to 2.73 parts of deionized water and combined with a mixture of Parts A and B of Topcoat No. 3 as described above. The tack-free times and initial gloss levels were determined as described above. The results are shown below in Table 6.

TABLE 6

Run No.	Initiator	Wt. % Initiator in Topcoat	Results		
			Topcoat Tack-Free Time (hours)	60° Gloss	20° Gloss
6-1	None	0.0	>24	82.8	44.3
6-2	AZrC	0.7	>23	86.1	59.9
6-3	AZrC	2.1	12	83.2	53.7
6-4	AZrC	3.4	10	67.4	21.2
6-5	KZrC	0.7	11	87.2	64.1
6-6	KZrC	2.1	4	74	52.1
6-7	KZrC	3.4	2.5	84.3	58.7

[0072] The results in Table 6 demonstrate that zirconium carbonates could substantially reduce tack-free times when added to a polyurethane topcoat, with little or no loss of gloss.

EXAMPLE 7

[0073] Using the method of Example 5, varying amounts of ammonium zirconium carbonate or potassium zirconium carbonate were added to 2.73 parts of deionized water and combined with a mixture of Parts A and B of Topcoat No. 4 as described above. The tack-free times and initial gloss

levels were determined as described above. The results are shown below in Table 7. "NM" indicates that the tack-free time was not measured, due to less than optimal observed coating quality.

TABLE 7

Run No.	Initiator	Wt. % Initiator in Topcoat	Results		
			Topcoat Tack-Free Time (hours)	60° Gloss	20° Gloss
7-1	None	0.0	>24	89	76.5
7-2	AZrC	0.7	>22	86.1	78.5
7-3	AZrC	2.1	11.5	88.2	76.5
7-4	AZrC	3.4	NM	19.7	2.7
7-5	KZrC	0.7	7.5	46.2	44.1
7-6	KZrC	2.1	3.5	85.8	71.1
7-7	KZrC	3.4	2.5	82.8	62.1

[0074] The results in Table 7 demonstrate that zirconium carbonates could substantially reduce tack-free times when added to a polyurethane topcoat, while providing very good gloss levels.

EXAMPLE 8

[0075] Using the method of Example 5, varying amounts of ammonium zirconium carbonate or potassium zirconium carbonate were added to 2.73 parts of deionized water and combined with a mixture of Parts A and B of Topcoat No. 5 as described above. The tack-free times and initial gloss levels were determined as described above. The results are shown below in Table 8. "NM" indicates that the tack-free time was not measured, due to less than optimal observed coating quality.

TABLE 8

Run No.	Initiator	Wt. % Initiator in Topcoat	Results		
			Topcoat Tack-Free Time (hours)	60° Gloss	20° Gloss
8-1	None	0.0	>20	89.6	80.4
8-2	AZrC	0.7	>20	87.5	80.4
8-3	AZrC	2.1	11.5	62.8	18.1
8-4	AZrC	3.4	NM	38.7	6
8-5	KZrC	0.7	9	84.7	59.1
8-6	KZrC	2.1	3.5	84.7	64.5
8-7	KZrC	3.4	3	84.1	61.3

[0076] The results in Table 8 demonstrate that zirconium carbonates could substantially reduce tack-free times when added to a polyurethane topcoat, while providing good gloss levels.

EXAMPLE 9

[0077] Using the method of Example 5, varying amounts of ammonium zirconium carbonate or potassium zirconium carbonate were added to 2.73 parts of deionized water and combined with a mixture of Parts A and B of Topcoat No. 6 as described above. The tack-free times and initial gloss levels were determined as described above. The results are shown below in Table 9.

TABLE 9

Run No.	Initiator	Wt. % Initiator in Topcoat	Results		
			Topcoat Tack-Free Time (hours)	60° Gloss	20° Gloss
9-1	None	0.0	>23	89.6	81.8
9-2	AZrC	0.7	>22	87	77.1
9-3	AZrC	2.1	11.5	86.4	68.2
9-4	AZrC	3.4	9.5	14.5	1.4
9-5	KZrC	0.7	8	85.1	58.6
9-6	KZrC	2.1	4	71.9	41.2
9-7	KZrC	3.4	2.5	86.1	66

[0078] The results in Table 9 demonstrate that Zirconium carbonates could substantially reduce tack-free times when added to a polyurethane topcoat, while providing good gloss levels.

EXAMPLE 10

[0079] Part A of Topcoat No. 2 was modified by combining it with 4%, 8% or 12% ADURA™ 50 polyol (40% solids, from Air Products & Chemicals Co.). 28.2 Parts of the resulting mixture were combined with 9.02 parts TOLONATE™ HDT polyisocyanate (from Rhodia Corp.) and mixed for 3 minutes. Varying amounts of potassium zirconium carbonate were next added to 2.78 parts of deionized water, combined with the above-described mixture and mixed for 30 seconds. The mixtures were coated onto clean tiles. Using the general method of Example 1, the polyurethane tack-free times and initial gloss levels at the various polyol addition levels were determined. The results are shown below in Table 10.

TABLE 10

Run No.	Wt % ADURA 50 Polyol in Part A	Initiator	Wt. % Initiator in Topcoat	Results		
				Topcoat Tack-Free Time (hours)	60° Gloss	20° Gloss
10-1	4	KZrC	0.0	>20	89.7	81
10-2	4	KZrC	0.7	7	85.8	56.6
10-3	4	KZrC	2.1	2.5	87.5	72.8
10-4	4	KZrC	3.4	2	58.8	31.1
10-5	8	KZrC	0.0	>20	89.5	80.3
10-6	8	KZrC	0.7	8	892	59.2
10-7	8	KZrC	2.1	3.5	89.3	76.8
10-8	8	KZrC	3.4	3	78.7	44.9
10-9	12	KZrC	0.0	>20	89.8	87
10-10	12	KZrC	0.7	8	82.6	45.3
10-11	12	KZrC	2.1	3	89.4	73.5
10-12	12	KZrC	3.4	2	82.9	50.9

[0080] The results in Table 10 demonstrate that a zirconium carbonate could substantially reduce tack-free times when added to a polyurethane topcoat, while providing good gloss levels.

EXAMPLE 11

[0081] Using the general method of Example 10, 28.2 parts of Topcoat No. 2 Part A were combined with 9.02 parts TOLONATE™ HDT polyisocyanate (from Rhodia Corp.)

and mixed for 3 minutes. Varying amounts of potassium zirconium carbonate, K-KAT™ XC-6212A zirconium chelate catalyst (from King Industries, Inc.) or METACURE™ T-12 dibutyltin dilaurate (from Air Products & Chemicals, Inc.) were also added to the Part A:Part B mixture or to Part A alone before mixing with Part B. Potassium zirconium carbonate was added by combining it with 2.78 parts of deionized water, combining the resulting mixture with the Part A:Part B mixture and mixing for 30 seconds. The zirconium chelate catalyst and dibutyltin dilaurate catalyst were added by combining them with Part A, mixing, adding part B, mixing for 3 minutes, adding 2.78 parts of deionized water and mixing for 30 seconds. The amounts of zirconium chelate catalyst and dibutyltin dilaurate catalyst employed were at approximately or above the high end of the respective manufacturer's recommendations. Using the general method of Example 1, the polyurethane tack-free times and gloss levels were determined for compositions applied immediately after the start of mixing and after 30 minute, 45 minute and 60 minute standing times following the start of mixing. The results are shown below in Table 11.

TABLE 11

Run No.	Initiator	Wt. % Initiator in Part A	Wt. % Initiator in Topcoat	Standing Time, min	Results		
					Topcoat Tack-Free Time (hours)	60° Gloss	20° Gloss
11-1	KZrC	2.5	1.8	0	5	42.4	9.6
11-2	KZrC	2.5	1.8	30	5	73.4	36.6
11-3	KZrC	2.5	1.8	45	5	80.6	51.3
11-4	KZrC	2.5	1.8	60	5	71.6	30.1
11-5	KZrC	4.0	2.8	0	3.5	60	31.7
11-6	KZrC	4.0	2.8	30	3.5	17.5	5.2
11-7	KZrC	4.0	2.8	45	3.5	71.5	46.6
11-8	KZrC	4.0	2.8	60	3.5	32	11
11-9	K-KAT	0.5	0.4	0	>24	88.6	75.2
11-10	K-KAT	0.5	0.4	30	>24	88.5	71
11-11	K-KAT	0.5	0.4	45	>24	89.3	70.3
11-12	K-KAT	0.5	0.4	60	>24	86.6	66
11-13	K-KAT	0.8	0.6	0	>24	13.9	50.5
11-14	K-KAT	0.8	0.6	30	>24	72.7	32.7
11-15	K-KAT	0.8	0.6	45	>24	85.8	60
11-16	K-KAT	0.8	0.6	60	>24	74.4	33
11-17	T-12	0.2	0.1	0	6	24.7	3.1
11-18	T-12	0.2	0.1	30	6	21.3	1.7
11-19	T-12	0.2	0.1	45	6	4.3	0.2
11-20	T-12	0.2	0.1	60	6	1.9	0.2
11-21	T-12	0.5	0.4	0	3.5	4.2	0.3
11-22	T-12	0.5	0.4	30	3.5	1.4	0.1
11-23	T-12	0.5	0.4	45	3.5	0.7	0
11-24	T-12	0.5	0.4	60	3.5	0.5	0

[0082] The results in Table 11 show that a zirconium carbonate could provide greater reduction in polyurethane tack-free times than a manufacturer-recommended amount of an organic zirconium chelate compound. The results in Table 11 also show that a zirconium carbonate could provide polyurethane tack-free times that were comparable to those obtained using a manufacturer-recommended amount of dibutyltin dilaurate, while providing better gloss levels

EXAMPLE 12

[0083] Using the general method of Example 10, 24.816 parts of Topcoat No. 2 Part A were combined with 3.384 parts ADIURA 50 polyol to provide 28.2 parts of a modified

Part A like that used in Run Nos. 10-9 through 10-12. The modified Part A was mixed with 9.02 parts TOLONATE™ HDT polyisocyanate (from Rhodia Corp.) for 3 minutes to provide a Part A:Part B mixture. Using the method of Example 10, potassium zirconium carbonate, varying amounts of K-KAT XC-6212A zirconium chelate catalyst, or METACURE T-12 dibutyltin dilaurate were also added to the Part A:Part B mixture or to Part A prior to mixing with Part B. Using the general method of Example 1, the polyurethane tack-free times of the initial coatings were measured. The gloss levels were determined for compositions applied immediately after the start of mixing and after 30 minute and 45 minute standing times following the start of mixing. The results are shown below in Table 12.

TABLE 12

Run No.	Initiator	Wt. % Initiator in Part A	Wt. % Initiator in Topcoat	Standing Time, min	Results		
					Topcoat Tack-Free Time (hours)	60° Gloss	20° Gloss
12-1	KZrC	3.0	2.07	0	3.5	87.2	69.9
12-2	KZrC	3.0	2.07	30		87	63.2
12-3	KZrC	3.0	2.07	45		84.4	57.3
12-4	K-KAT	0.8	0.56	0	>15	89.9	75.8
12-5	K-KAT	0.8	0.56	30		90.6	75.8
12-6	K-KAT	0.8	0.56	45		91.1	75.3
12-7	K-KAT	1.6	1.10	0	>15	86.7	60.5
12-8	K-KAT	1.6	1.10	30		87.5	65.3
12-9	K-KAT	1.6	1.10	45		87.1	64.8
12-10	T-12	0.2	0.14	0	9	81.7	44.4
12-11	T-12	0.2	0.14	30		71.3	25.3
12-12	T-12	0.2	0.14	45		67	21.3

[0084] The results in Table 12 show that zirconium carbonate could provide greater reduction in polyurethane tack-free times than manufacturer-recommended amounts of an organic zirconium chelate compound or dibutyltin dilaurate, and could provide good gloss levels.

[0085] Various modifications and alterations of this invention will be apparent to those skilled in the art without departing from the scope and spirit of this invention. It should be understood that this invention is not limited to the illustrative embodiments set forth above.

We claim:

1. An autohardenable polyurethane coating comprising sufficient zirconium carbonate to decrease the coating tack-free time.
2. A coating according to claim 1 wherein the zirconium carbonate comprises sodium zirconium carbonate.
3. A coating according to claim 1 wherein the zirconium carbonate comprises potassium zirconium carbonate.
4. A coating according to claim 1 wherein the zirconium carbonate comprises ammonium zirconium carbonate.
5. A coating according to claim 1 comprising sufficient zirconium carbonate to decrease the coating tack-free time by at least about 10%.
6. A coating according to claim 1 comprising sufficient zirconium carbonate to decrease the coating tack-free time by at least about 30%.

7. A coating according to claim 1 comprising sufficient zirconium carbonate to decrease the coating tack-free time by at least about 50%.

8. A coating according to claim 1 containing about 0.01 to about 15 wt. % zirconium carbonate.

9. A coating according to claim 1 containing about 0.1 to about 10 wt. % zirconium carbonate.

10. A coating according to claim 1 wherein the polyurethane comprises a polyisocyanate and a polyester polyol, polyether polyol, acrylic polyol, polyurethane polyol or combination thereof.

11. A coating according to claim 1 wherein the polyurethane comprises a waterborne multicomponent polyurethane.

12. A coating according to claim 1 atop a flooring substrate.

13. A method for applying a polyurethane finish comprising applying to a substrate a layer of an autohardenable polyurethane coating comprising sufficient zirconium carbonate to decrease the coating tack-free time.

14. A method according to claim 13 wherein the zirconium carbonate comprises sodium zirconium carbonate.

15. A method according to claim 13 wherein the zirconium carbonate comprises potassium zirconium carbonate.

16. A method according to claim 13 wherein the zirconium carbonate comprises ammonium zirconium carbonate.

17. A method according to claim 13 wherein the coating comprises sufficient zirconium carbonate to decrease the coating tack-free time by at least about 10%.

18. A method according to claim 13 wherein the coating comprises sufficient zirconium carbonate to decrease the coating tack-free time by at least about 30%.

19. A method according to claim 13 wherein the coating comprises sufficient zirconium carbonate to decrease the coating tack-free time by at least about 50%.

20. A method according to claim 13 wherein the coating contains about 0.01 to about 15 wt. % zirconium carbonate.

21. A method according to claim 13 wherein the coating contains about 0.1 to about 10 wt. % zirconium carbonate.

22. A method according to claim 13 comprising forming the polyurethane by combining a polyisocyanate and a polyester polyol, polyether polyol, acrylic polyol, polyurethane polyol or combination thereof

23. A method according to claim 13 wherein the polyurethane comprises a waterborne multicomponent polyurethane.

24. A method according to claim 13 wherein the substrate comprises a floor.

25. A method according to claim 24 further comprising walking on the polyurethane after it has become tack-free to apply a further polyurethane layer or a layer of another film-forming material.

26. A jobsite-renewable point of use floor finish system comprising a substantially isocyanate-free undercoat, an autohardenable polyurethane topcoat and instructions for jobsite application of the undercoat to a floor and the topcoat to the undercoat, wherein the undercoat or topcoat comprise sufficient zirconium carbonate to decrease the topcoat tack-free time.

27. A system according to claim 26 wherein the zirconium carbonate comprises sodium zirconium carbonate.

28. A system according to claim 26 wherein the zirconium carbonate comprises potassium zirconium carbonate.

29. A system according to claim 26 wherein the zirconium carbonate comprises ammonium zirconium carbonate

30. A system according to claim 26 comprising sufficient zirconium carbonate to decrease the polyurethane tack-free time by at least about 10%.

31. A system according to claim 26 comprising sufficient zirconium carbonate to decrease the polyurethane tack-free time by at least about 30%.

32. A system according to claim 26 comprising sufficient zirconium carbonate to decrease the polyurethane tack-free time by at least about 50%.

33. A system according to claim 26 wherein the polyurethane contains about 0.01 to about 15 wt. % zirconium carbonate.

34. A system according to claim 26 wherein the polyurethane contains about 0.1 to about 10 wt. % zirconium carbonate.

35. A system according to claim 26 wherein the undercoat contains about 1 to about 50 wt. % zirconium carbonate.

36. A system according to claim 26 wherein the undercoat contains about 2 to about 30 wt. % zirconium carbonate.

37. A system according to claim 26 wherein the topcoat and undercoat comprise zirconium carbonate.

38. A system according to claim 26 wherein the polyurethane comprises a waterborne multicomponent polyurethane.

39. A system according to claim 38 wherein the polyurethane components comprise (a) a polyisocyanate and (b) a polyester polyol, polyether polyol, acrylic polyol, polyurethane polyol or combination thereof.

40. A system according to claim 26 further comprising a waterborne maintenance coat composition.

41. A system according to claim 26 further comprising a stripper.

42. A system according to claim 26 wherein the hardened polyurethane and undercoat can be removed from the floor by applying a stripper composition comprising at least one polar solvent, allowing the stripper composition to contact the polyurethane for sufficient time to soften the polyurethane and undercoat, and removing the softened polyurethane and undercoat without removing substantial portions of the floor

43. A method for applying a jobsite-renewable finish to a floor comprising applying to the floor a multilayer coating system comprising a layer or layers of a substantially isocyanate-free undercoat and a layer or layers of an autohardenable polyurethane topcoat, wherein the undercoat or topcoat comprise sufficient zirconium carbonate to decrease the topcoat tack-free time.

44. A method according to claim 43 wherein the zirconium carbonate comprises sodium zirconium carbonate.

45. A method according to claim 43 wherein the zirconium carbonate comprises potassium zirconium carbonate.

46. A method according to claim 43 wherein the zirconium carbonate comprises ammonium zirconium carbonate

47. A method according to claim 43 wherein the undercoat or topcoat comprise sufficient zirconium carbonate to decrease the polyurethane tack-free time by at least about 10%.

48. A method according to claim 43 wherein both the undercoat and polyurethane comprise zirconium carbonate.

49. A method according to claim 43 wherein the undercoat comprises zirconium carbonate and the topcoat does not.

50. A method according to claim 43 comprising applying a layer of undercoat that comprises zirconium carbonate, a layer of undercoat that does not contain zirconium carbonate, and a layer of topcoat.

51. A method according to claim 50 wherein the topcoat also comprises zirconium carbonate.

52. A method according to claim 43 wherein the polyurethane comprises a waterborne multicomponent polyurethane.

53. A method according to claim 52 wherein the polyurethane components comprise (a) a polyisocyanate and (b) a polyester polyol, polyester polyol, acrylic polyol, polyurethane polyol or combination thereof.

54. A method according to claim 43 wherein the hardened polyurethane and undercoat can be removed from the floor

by applying a stripper composition comprising at least one polar solvent, allowing the stripper composition to contact the polyurethane for sufficient time to soften the polyurethane and undercoat, and removing the softened polyurethane and undercoat without removing substantial portions of the floor.

55. A method according to claim 43 wherein the floor comprises wood, vinyl or vinyl composite.

56. A method according to claim 43 further comprising walking on the polyurethane after it has become tack-free to apply a further polyurethane layer or a layer of another film-forming material.

* * * * *