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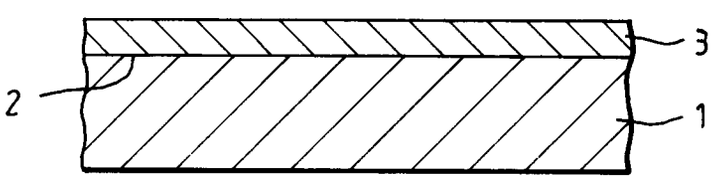
(54) Polymeric film.

(57) A surface textured film has a coating providing the surface texture designed to impart suitable friction and handling characteristics. The texture is produced by coating the film substrate with a composition comprising a polymerisable component, preferably a metal (meth)acrylate, dissolved or dispersed in a volatile vehicle and drying the coating. Removal of the vehicle causes phase separation and/or retraction of the components to produce the surface texture.

Fig.1



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This invention relates to a polymeric film, in particular, to a polymeric film comprising a surface textured coating and especially to a thermal transfer dye sheet comprising a surface-textured back coat.

There is a requirement for surface textured films to provide tactile and visual appeal and desirable friction/handling characteristics in a range of commercial applications, for example - protective antiglare film for membrane touch switch overlay sheets, ink/pencil receptive films for drafting media and durable backing films for flexible data storage media - for example, optical data storage, magnetic tape and magneto-optical tape, and for thermal transfer printing dye sheets.

Thermal transfer printing dye sheets typically comprise a substrate having on one side a dye coat layer, conventionally comprising a dye and a binder and, on the other side, a back coat layer. Thermal transfer printing applications, both dye diffusion thermal transfer and laser thermal transfer, involve placing the dye sheet in intimate contact with a receiver sheet and selectively heating pre-determined areas of the dye sheet to promote thermal transfer of dye in the heated areas to the receiver sheet thereby forming an image on the receiver sheet. The dye coat is conventionally very smooth to enable intimate contact between the dye coat on the dye sheet and the receiver sheet to which an image is to be transferred.

In dye diffusion thermal transfer, the heating is effected by means of thermal print heads which are in contact with the back coat of the dye sheet. In laser thermal transfer processes, the dye coat is heated by means of a laser beam which is typically directed through the back coat and substrate to effect heating of the dye coat.

GB 2113117 discloses a slippery biaxially stretched polyester film having a coating which is a mixture of a metal (meth)acrylate having one (meth)acrylate function per organic moiety, and a polymeric film-forming material or monomer precursor. GB2113117 also discloses a process for the production of such films. This process involves coating a surface of a running polyester film before the completion of its crystalline orientation and heating the coating prior to completing the orientation of the film. However, the textured coating formed in such a process may be stretched in completing the orientation of the polyester film or may suffer from loss of adhesion to the substrate due to sheering effects between the coating and the substrate.

We have now devised a polymeric film comprising a surface textured coating preferably having a plurality of components, which overcomes or substantially eliminates the aforementioned problems.

According to a first aspect of the invention, there is provided a surface textured film comprising a polymeric substrate having on at least one surface thereof a surface textured coating comprising a cured material comprising at least one polymer wherein the surface texture is imparted primarily by the polymer or polymers per se and wherein the substrate is not oriented after the coating is formed.

Desirably, the substrate is oriented, either uniaxially or preferably biaxially, in which case, the surface texture is imparted to the film after the substrate is oriented.

Films according to the first aspect of the invention are advantageous as the surface relief of the surface textured coating is not modified by orientation after it has been formed thus a greater control over the surface relief may be exercised in the formation of the coating. Furthermore, the adherance of the surface textured coating to the substrate is retained due to the absence of stretching of the film.

Orientation of the film following application of the surface textured coating may modify the said coating, particularly if the coating has a low degree of cross-linking, by reducing the out-of-plane displacement of the coating, that is "flattening" the surface texture, and thus reducing the surface roughness of the film.

Surface roughness is a desirable characteristic for a film to possess in many applications, for example thermal transfer printing, where handling properties are important.

Prior art films which have low surface roughness may present problems due to poor handling characteristics in such applications.

According to a second aspect of the invention, there is provided a surface textured film comprising a polymeric substrate having on at least one surface thereof a surface textured coating comprising a cured material comprising at least one polymer wherein the surface texture is imparted primarily by the polymer or polymers per se and the film has an average surface roughness (Ra) of at least 0.05 μm.

Films according to the second aspect of the invention have excellent handling characteristics, wear resistance which is desirable in membrane touch switch applications and wear and winding characteristics, desirable in optical data storage applications.

In thermal transfer printing applications, such films are particularly useful as backcoats for dye transfer sheets. The higher surface roughness of the surface textured back coat reduces the possibility of unwanted transfer of dye from the smooth dye coat to the back coat of an adjacent sheet when the dye sheets are in a stack.

Furthermore, in thermal transfer printing, the surface textured back coat facilitates smooth transport of the dye sheet through the printer and, in dye diffusion transfer, reduces blocking of the dye sheet against the printer head.

We have found that by employing a multifunctional (meth)acrylate, (acrylate and/or methacrylate), ester

organic polymer, a surface textured coating having improved durability, thermal stability, hardness and wear resistance may be secured.

According to a third aspect of the invention, there is provided a surface textured film comprising a polymeric substrate having on at least one surface thereof a surface textured coating comprising a cured material comprising at least one multi-functional (meth)acrylate ester polymer wherein the surface texture is imparted primarily by the polymer or polymers per se.

By "multi-functional (meth)acrylate ester polymer" we mean an acrylate monomer which has more than one acrylate function per monomer and which has been polymerised to produce the polymer.

By "monomer" we mean a true monomer and/or an oligomer/pre-polymer which can be cured.

The (meth)acrylate ester polymer is, at least in part, cross-linked due to the multi-functionality of the monomer. This is advantageous in thermal transfer printing applications as the polymer is less prone to softening at the high temperatures, typically above 250°C, employed in thermal transfer printing as compared with linear or non cross-linked polymers.

The surface textured coating of films according to the third aspect of the invention possess advantageous wear resistance and thermal stability and, as such, provide excellent back coats for thermal transfer printing dye sheets.

The improved hardness of a surface textured coating of such films is beneficial in optical data storage tape products having a surface textured back coat as the back coat is less deformed under pressure such as that encountered when the tape is wound on spools.

Suitably, the surface textured coating of a film according to the third aspect of the invention comprises at least 1%, preferably 25 to 100% and especially 75 to 100% by weight of a multi-functional (meth)acrylate ester polymer based on the cured components in the coating.

Further, it is preferred that at least 10%, preferably 30 to 100% and especially 50 to 100% of the available (meth)acrylate double bonds present in the coating, that is any multi-functional (meth)acrylate ester and any other (meth)acrylate component, are converted to single bonds by curing the coating.

The degree of conversion is measured using the FTIR absorbance ratio by comparing the unsaturation peak at about 810cm^{-1} due to $=CH_2$ twisting with the internal reference peak at 1158cm^{-1} due to the C-O stretch of the acrylic group. The absorbance ratio 810cm^{-1}/1158cm^{-1} of the cured coating is compared with that of the uncured coating to determine the degree of conversion.

The invention also provides a surface textured film comprising a polymeric substrate having on at least one surface thereof a surface textured coating comprising a cured material comprising at least one polymerised component wherein the surface texture of the coating is induced at least in part, preferably primarily as a result of evaporation of a volatile vehicle from a coating composition comprising the said volatile vehicle and the unpolymerised component(s).

The invention further provides a dyesheet for thermal transfer printing which comprises a surface textured film according to the present invention having the surface textured coating on one surface of the substrate and having a dye layer on the other surface of the substrate.

A further aspect of the invention provides a method of producing a surface texture film which comprises coating a polymeric substrate with a solution or dispersion of a material in a volatile vehicle, drying the coating to remove at least part, preferably substantially all of the volatile vehicle, the material comprising at least one polymerisable component such that the drying process is effective to impart a surface texture to the dried layer formed by the coating of material, and curing the dried layer.

By "surface textured" we mean surface effects on the surface layer of a cured coating on a film wherein a major proportion and more preferably substantially all, of the surface effects are due to retraction of at least one component of the coating and/or, where the coating comprises at least two components, phase separation between at least two of the said components.

Desirably, the surface textured coating is substantially free of conventional fillers, for example alumina and silica for optical data storage applications. However the presence of a conventional filler may be desirable in other applications for example in drafting films.

It is preferred that substantially no shrinkage of the coating as a result of a chemical process, for example polymerisation and cross-linking, occurs prior to the curing of the polymerisable component. If any such shrinkage of the coating does occur, it is preferred that it does not contribute substantially, in relation to the retraction and/or phase separation, to the surface effects of the coating.

Suitably, a major proportion, preferably substantially all of the surface effects of the coating are formed before the polymerisable component is cured.

The polymer or polymerised component of the surface textured coating suitably comprises a metal (meth)acrylate and/or a polymerised monomer.

As herein described and employed, the metal (meth)acrylate preferably comprises a multivalent metal ion,

for example a transition metal ion such as zirconium, more preferably a divalent metal ion such as zinc, cobalt, nickel or copper. A metal acrylate is generally preferred to a metal methacrylate. A particularly preferred metal acrylate is zinc diacrylate. The amount, structure, molecular weight and functionality of the monomer can influence the surface relief and properties of the cured coating. The monomer can be selected to optimise the coating requirements for a particular application, such as surface roughness; optical properties, eg haze; mechanical properties, eg abrasion resistance; flexibility; adhesion; solvent/chemical resistance; and weatherability.

The monomer is suitably a UV-reactive species, and more preferably a compound having an (meth)acrylate functional group. Particularly suitable monomers include (meth)acrylate ester monomers, urethane (meth)acrylate oligomers and N-vinyl lactam monomers.

Preferred (meth)acrylate ester monomers include (meth)acrylate esters having a plurality of (meth)acrylate groups, with trimethylolpropane triacrylate (TMPTA), ethoxylated TMPTA (TMPTEOA), tripropylene glycol diacrylate (TPGDA), and dipentaerythritol monohydroxy pentaacrylate (DPEPA) being particularly preferred.

Preferred (meth)acrylate oligomers include polyester (meth)acrylates and epoxy (meth)acrylates, with oligomeric (meth)acrylate thioethers - for example TMPTA-[S-TMPTA]$_n$-S-TMPTA where n is 0 to 2 which is available from Röhm GmbH under the trade name PLEX 6696-0, and urethane (meth)acrylates, especially aliphatic urethane (meth)acrylate oligomers, being particularly preferred.

Preferred N-vinyl lactam monomers include N-vinyl pyrrolidone and N-vinyl caprolactam.

The monomer may also be a cationic cured epoxy compound such as a cyclo aliphatic diepoxide, for example, 3,4-epoxycyclohexylmethyl-3′,4′-epoxycyclohexane carboxylate available under the trade name DEGACURE K126 from Degussa. In this case it is desirable that a cationic photoinitiator - such as a triarylsulphonium salt may also be present.

A blend of (meth)acrylate ester monomer and/or (meth)acrylate oligomer and/or N-vinyl lactam monomer may also be used as a monomer, particularly blends of DPEPA and PLEX 6696-0. An N-vinyl lactam monomer, if present in the blend, may suitably comprise up to 40 % by weight and preferably no more than 30% by weight of the blend. Cationic cured epoxy compound may also be in such blends of monomers.

The amount of monomer in the coating composition can vary over a wide range, preferably from 0 to 95%, more preferably 60 to 90 %, and particularly 66 to 85 % by weight of the total reactive components.

When the coating composition comprises a metal (meth)acrylate, particularly zinc diacrylate, and a monomer, the metal (meth)acrylate may separate out from the monomer to form a two-phase system, as the solvent is removed by for example drying. The surface relief of the resulting surface coating is dependent on the ratio of the salt to the monomer. In certain ratios, the surface relief can be described as a discontinuous metal (meth)acrylate phase or ionomeric phase embedded in a continuous polymeric phase. Depending upon the compatibility of the metal (meth)acrylate and the monomer, it is possible that some of the monomer may be incorporated in the ionomeric phase and/or that some of the metal (meth)acrylate may be incorporated in the polymeric phase .

The presence of a monomer in the coating formulation may result in an improvement in the durability of the resulting surface textured coating.

In order to secure phase separation, the coating composition may also comprise a polymer component which suitably is substantially incompatible with at least one other component of the composition and preferably all of the components of the composition.

Suitable polymer components include high molecular weight epoxy polymers which are soluble the medium from which the surface textured coating may be applied and which preferably have a molecular weight of 1000 to 5000 and more preferably from 3000 to 4000. Suitable examples include bisphenol A epichlorohydrin condensates for example EPIKOTE 1009, an epoxy resin available from Shell and cellulosic polymersfor example cellulose acetate.

The amount of polymer component in the coating composition may vary over a wide range and is determined by the application for which the film is required. The polymer component may be present in an amount of up to 90 %, preferably 1 to 80 % and especially 20 to 60 % by weight of the total reactive components.

The polymerisable component is conveniently applied to the substrate in a coating medium comprising a solution or dispersion of the polymerisable component in a suitable volatile vehicle, particularly an organic solvent or dispersant medium. The volatile vehicle may then be removed, suitably by drying to evaporate the vehicle.

Suitable organic media include common solvents - for example acetone, tetrahydrofuran and preferably those which have a hydrogen bonding capability such as alcohols, particularly methanol or any combination thereof.

Deposition of the polymerisable component solution or dispersion onto the polymeric substrate is effected by conventional film coating techniques - for example, by gravure roll coating, reverse roll coating, dip coating, bead coating, slot coating or electrostatic spray coating. The solution or dispersion is suitably applied in an

amount such that the thickness of the applied layer when dried is of the order of 25 μm, or less, for example from 0.1 to 20 μm, and preferably in a range of from 0.5 to 20 μm.

The thickness of the applied layer is suitably determined by the particular application for which the film is to be used, for example, [DYE COAT THICKNESSES?]for membrane touch switch applications, it is preferred that the thickness of the applied layer is 1 to 20 μm and more preferably 2 to 10 μm, and for optical data storage applications, preferably 5 μm or less, especially 0.5 to 4 μm.

The degree of surface texture obtained can be controlled by varying the rate of drying of the polymerisable component layer, for example rapid drying of, for example, zinc diacrylate (1 min at 100°C) can produce a regular microcrystalline structure imparting texture and light scattering to the coated film.

A nucleating agent may be present in the coating composition and serves to provide sites in the substantially un-cured coating at which the polymerisable component car crystallise. A suitable nucleating agent may already be present in the polymerisable component component - for example commercially available grades of zinc diacrylate which have been investigated have been found to contain small quantities of a material which is insoluble in a suitable coating solvent for example methanol. Preliminary analysis has indicated that this material is partially polymerised zinc diacrylate and/or zinc stearate. When solutions of commercially available zinc diacrylate, for example, technical grade zinc diacrylate avaiable from Röhm, are prepared in methanol some (of the order of 0.11 by weight compared to the amount of zinc diacrylate) of the higher molecular weight material remains suspended in solution for several days as a colloidal dispersion. The colloidal component aids formation of surface texture, remains stable in the coating solution and may be uniformly distributed in the coated layer after drying.

If a polymerisable component is used which does not contain a suitable nucleating agent it may be necessary to add a nucleating agent to the coating composition, for example silica, preferably amorphous silica and carbon black, both available from Degussa under the trade names AEROSIL TT600 and PRINTEX XE2 respectively.

Once the solvent has been removed from the polymerisable component layer, it is necessary to cure the layer in order to fix the surface texture produced during the solvent removal regime. Suitable curing methods include polymerisation of the polymerisable component, for example by electron beam curing; thermal curing, preferably using thermal initiators, especially thermal free radical initiators such as inorganic or organic peroxides, for example benzoyl peroxide, azo compounds, for example 2,2′- azobisisobutyronitrile; but photopolymerisation is preferred.

Photopolymerisation is suitably achieved by exposing the solvent-free polymerisable component layer to high intensity ultra-violet (UV) light, for example using a mercury arc lamp, preferably a medium pressure mercury arc lamp, providing UV light having a wavelength of about 240 to about 370 nm and preferably 260 to 370 nm. UV-curing can be performed in air, or if required, for example to increase the curing rate, in an inert atmosphere such as nitrogen.

Initiation of photopolymerisation may be effected in the presence of a photoinitiator, a wide range of which are commercially available particularly for use in a system comprising polymerisable components. The photoinitiator is preferably incorporated in an amount ranging from 0.1 to 20%, more preferably 2 to 12% by weight of the total reactive components.

Suitable photoinitiators include benzoins, benzoin alkyl ethers, benzil ketals, acetophenone derivatives, for example dialkyl acetophenones and di-chloro and tri-chloro acetophenones, and particularly IRGACURE 651 and IRGACURE 907 both of which are available from Ciba Geigy.

If desired, a supercoat may be applied to the surface textured coating of a film according to the invention to provide protection therefor. In order to retain the benefit of the surface relief of the surface textured coating it is highly desirable that the supercoat follows the contours of the surface relief and is applied in a layer of substantially uniform thickness.

We have found that a supercoat having a low surface energy, preferably not more than 44 dyne/cm, more preferably not more than 36 dyne/cm and especially in the range 16 to 36 dyne/cm, is particularly advantageous. Such supercoats reduce the affinity of the supercoat of the film for the opposite surface thereof..

Suitably the low surface energy supercoat comprises a hydrocarbon wax, a silicone polymer/prepolymer, desirably silicone (meth)acrylates - for example Ebecryl 1360 available from Union Carbide, and/or fluorinated polymers/prepolymers - for example 2,2,3,3 tetrafluoropropylmethacrylate available from Rohm GmbH.

The thickness of the supercoat will depend upon the application for which the film is produced but is preferably in the range 1nm to 2μm and especially 1nm to 0.5μm.

Prior to deposition of the surface textured coating medium onto the polymeric substrate the exposed surface thereof may be subjected to a surface-modifying treatment to provide a receptive layer thereon. The treatment may be chemical or physical, a convenient treatment, because of its simplicity and effectiveness, which is particularly suitable for the treatment of a polyolefin substrate, being to subject the exposed surface of the

substrate to a high voltage electrical stress accompanied by corona discharge. Alternatively, the receptive layer may be created by pretreating the substrate with a medium known in the art to have a solvent or swelling action on the substrate polymer. Examples of such media, which are particularly suitable for the treatment of a polyester substrate, include a halogenated phenol dissolved in a common organic solvent, for example a solution of p-chloro-m-cresol, 2,4-dichlorophenol, 2,4,5- or 2,4,6-trichlorophenol or 4-chlororesorcinol in acetone or methanol. In addition, and preferably, the treatment solution may contain a partially hydrolysed vinyl chloride-vinyl acetate copolymer. Such a copolymer conveniently contains from 60 to 98 per cent of vinyl chloride, and from 0.5 to 3% of hydroxyl units, by weight of the copolymer. The molecular weight (number average) of the copolymer is conveniently in a range of from 10,000 to 30,000 and preferably from 16,500 to 25,000.

A suitable receptive layer is formed by coating the polymeric substrate with a coating composition comprising an acrylic or methacrylic polymer, preferably comprising at least one monomer derived from an ester of acrylic acid, especially an alkyl ester where the alkyl group contains up to ten carbon atoms such as methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, terbutyl, hexyl, 2-ethylhexyl, heptyl, and n-octyl, Polymers derived from an alkyl acrylate, for example ethyl acrylate and butyl acrylate, together with an alkyl methacrylate are preferred. Polymers comprising ethyl acrylate and methyl methacrylate are particularly preferred . The acrylate monomer is preferably present in a proportion in the range 30 to 65 mole %, and the methacrylate monomer is preferably present in a proportion in the range of 20 to 60 mole %.

Other monomers which are suitable for use in the preparation of the acrylic or metacrylic polymer, which may be used instead of, but are preferably copolymerised as optional additional monomers together with esters of acrylic acid and/or methacrylic acid, and derivatives thereof, include acrylonitrile, methacrylonitrile, halo-substituted acrylonitrile, halo-substituted methacrylonitrile, acrylamide, methacrylamide, N-methylol acrylamide, N-ethanol acrylamide, N-propanol acrylamide, N-methacrylamide, N-ethanol methacrylamide, N-methyl acrylamide, N-tertiary butyl acrylamide, hydroxyethyl methacrylate, glycidyl acrylate, glycidyl methacrylate, dimethylamino ethyl methacrylate, itaconic acid, itaconic anhydride and half esters of itaconic acid.

Other optional monomers include vinyl esters such as vinyl acetate, vinyl chloracetate and vinyl benzoate, vinyl pyridine, vinyl chloride, vinylidene chloride, maleic acid, maleic anhydride, styrene and derivatives of styrene such as chloro styrene, hydroxy styrene and alkylated styrenes, wherein the alkyl group contains from one to ten carbon atoms.

A preferred acrylic or methacrylic polymer derived from 3 monomers comprises 35 to 60 mole % of ethyl acrylate: 30 to 55 mole % of methyl methacrylate: 2-20 mole % of methacrylamide, and particularly in a ratio of 46/46/8 mole % respectively..

The molecular weight of a suitable acrylic or methacrylic polymeric component can vary over a wide range but the weight average molecular weight is preferably within the range 40,000 to 300,000, and more preferably within the range 50,000 to 200,000.

Another suitable receptive layer is formed by coating the polymeric substrate with a mixture of the aforementioned acrylic or methacrylic polymer and a styrene/butadiene copolymer. A preferred styrene/butadiene copolymer has a molar ratio of styrene:butadiene of approximately 1.4:1.0. A preferred acrylic or methacrylic polymer for mixing with the styrene/butadiene copolymer comprises methyl methacrylate/ethyl acrylate/methacrylamide, preferably in a ratio of 46/46/8 mole % respectively. The weight ratio of the styrene/butadiene copolymer to acrylic or methacrylic polymer can vary over a wide range, preferably from 1.0:0.1 to 10.0, more preferably from 1.0:0.25 to 4.0, and particularly 1.0:1.0.

A preferred receptive layer has a low surface energy which facilitates retraction of the surface textured coating composition to form the surface textured coating. Such a receptive layer suitably comprises any of the materials which may be employed in a low surface energy supercoat as herein described. Desirably such a receptive layer may chemically react with the surface textured coating to promote adhesion between the receptive layer and the surface textured coating and preferably comprises acrylate double bonds which form react with acrylate groups in the surface textured coating for example when the said coating is cured.

If desired, a plurality of treatments may be sequentially applied to a substrate.

The treatment is suitably applied at a concentration or intensity which will yield a receptive layer having a dry thickness generally less than 1 μm, and preferably from 0.05 to 0.5 μm.

A polyester substrate, for example a polyethylene terephthalate film, may require one or more of the aforementioned surface treatments in order to obtain adequate adhesion of the surface textured layer to the substrate.

The substrate of a surface-textured film according to the invention may be formed from any synthetic, film-forming polymeric material. Suitable thermoplastics materials include a homopolymer or copolymer of a 1-olefin, such as ethylene, propylene and but-1-ene, a polyamide, a polycarbonate, and, particularly, a synthetic linear polyester which may be obtained by condensing one or more dicarboxylic acids or their lower alkyl (up to 6 carbon atoms) diesters, eg terephthalic acid, isophthalic acid, phthalic acid, 2,5- 2,6- or 2,7- naphthalene-

dicarboxylic acid, succinic acid, sebacic acid, adipic acid, azelaic acid, 4,4′-diphenyldicarboxylic acid, hexahydroterephthalic acid or 1,2-bis-p-carboxyphenoxyethane (optionally with a monocarboxylic acid, such as pivalic acid) with one or more glycols, particularly aliphatic glycols, eg ethylene glycol, 1,3- propanediol, 1,4-butanediol, neopentyl glycol and 1,4-cyclohexanedimethanol. A polyethylene naphthalate, and particularly a polyethylene terephthalate film is preferred, especially such a film which has been biaxially oriented by sequential stretching in two mutually perpendicular directions, typically at a temperature in the range 70 to 125°C, and preferably heat set, typically at a temperature in the range 150 to 250°C, for example - as described in British Patent GB-A-838708.

The substrate may also comprise a polyarylether or thio analogue thereof, particularly a polyaryletherketone, polyarylethersulphone, polyaryletheretherketone, polyaryletherethersulphone, or a copolymer or thioanalogue thereof. Examples of these polymers are disclosed in EP-A-1879, EP-A-184458 and US-A-4008203, particularly suitable materials being those sold by ICI PLC under the Registered Trade Mark STABAR. Blends of these polymers may also be employed.

Suitable thermoset resin substrate materials include addition - polymerisation resins - such as acrylics, vinyls, bis-maleimides and unsaturated polyesters, formaldehyde condensate resins - such as condensates with urea, melamine or phenols, cyanate resins, isocyanate resins, epoxy resins, functionalised polyesters, polyamides or polyimides.

A polymeric film substrate for production of a surface textured film according to the invention may be unoriented, or uniaxially oriented, but is preferably biaxially oriented. A thermoplastics polymeric substrate is conveniently biaxially oriented by drawing in two mutually perpendicular directions in the plane of the film to achieve a satisfactory combination of mechanical and physical properties. Simultaneous biaxial orientation may be effected by extruding a thermoplastics polymeric tube which is subsequently quenched, reheated and then expanded by internal gas pressure to induce transverse orientation, and withdrawn at a rate which will induce longitudinal orientation. Sequential stretching may be effected in a stenter process by extruding the thermoplastics substrate material as a flat extrudate which is subsequently stretched first in one direction and then in the other mutually perpendicular direction. Generally, it is preferred to stretch firstly in the longitudinal direction, ie the forward direction through the film stretching machine, and then in the transverse direction. A stretched substrate film may be, and preferably is, dimensionally stabilised by heat-setting under dimensional restraint at a temperature above the glass transition temperature thereof.

The surface textured coating medium is suitably applied to a receptive surface of an already oriented, and preferably heat-set, film substrate.

The thickness of the substrate of a surface textured film according to the invention may vary over a wide range, but generally will be up to 300, preferably from 2 to 250 μm and, for optical data storage applications, especially from 2 to 75 μm, and for membrane touch switch applications, especially from 125 to 250 μm. The thicknesses of the respective layers deposited on the substrate are minor by comparison therewith. A film according to the invention may therefore be expected to exhibit a total thickness of from about 5 to 310 μm, especially 10 to 260 μm.

A surface textured layer may be applied to one or each surface of the polymeric substrate. Alternatively, one surface of the substrate may be uncoated, or may be coated with a layer or layers other than the herein specified surface textured layer. In a preferred embodiment of the invention, a surface textured film comprises a four layer structure: a substrate layer of a film-forming resin, such as a linear polyester, having on each surface thereof a receptive layer, and a surface textured layer on the remote surface of one of the receptive layers.

One or more of the polymeric layers of a film according to the invention may conveniently contain any of the additives conventionally employed in the manufacture of thermoplastics polymeric films. Thus, agents such as anti-static agents, dyes, pigments, voiding agents, lubricants, anti-oxidants, anti-blocking agents, surface active agents, slip aids, gloss-improvers, prodegradants, ultra-violet light stabilisers, viscosity modifiers and dispersion stabilisers may be incorporated in the substrate and/or receptive layer(s) and/or surface textured layer(s), as appropriate.

A film according to the invention is of utility in a wide range of applications, including membrane touch switch (MTS) assemblies, data storage media, drafting media and dye sheet backing for thermal transfer printing in which films of the present invention may exhibit improved friction characteristics at the elevated temperatures found in thermal transfer printing applications.

The invention is illustrated by reference to the accompanying drawings in which:

Figure 1 is a schematic elevation (not to scale) of a portion of a surface textured film comprising an oriented polymeric substrate (1) on a first surface (2) of which is a surface textured layer (3),

Figure 2 is a fragmentary schematic elevation of a similar film in which an additional receptive layer (4) is included between the substrate (1) and surface textured layer (3), and

Figure 3 is a fragmentary schematic elevation of a film similar to that of Figure 2 with the addition of a second

receptive layer (6) on the remote surface (5) of the substrate (1).

The invention is further illustrated by reference to the following Examples.

In evaluating the products of the Examples, the following Test Procedures were adopted:

TEST PROCEDURES

1 Adhesion to support

Adhesion was assessed by, I) scoring through the coatings a cross hatch pattern consisting of 9 squares within a 2 x 2 cm area using the edge of a scalpel, II) adhering firmly Tesa tape 4104 over the test area, III) sharply removing the tape, IV) assessing the amount of coating removed by the number of non-intact squares, and V) repeating stages II)-IV) a further seven times. Adhesion is expressed as the number of squares removed over the number of tape pulls eg 0/8 = no coating removed after 8 tape pulls.

2 Surface Roughness

Surface roughness was measured using a Perthometer S6P surface measuring and recording instrument having a "free tracing system" and a datum pick-up No FTK 3-50 to measure the average roughness (Ra) and the average groove distance (Rsm) on the film under test.

3 Optical Properties

Haze and Total Light Transmission (TLT) of the film under test were measured using a Gardner/Neotec Instruments model XL211 Hazegard System using a 5cm x 5cm sample of the film from which the Haze and TLT values were taken as direct readings. Three runs were conducted for each film and the average of the results for each film was recorded.

Gloss measurements were obtained by a method based on ASTM D 523-67 Standard Method of Test for Specular Gloss using a model DS29 Universal Digital Readout and a Highspec Glosshead Model 10 supplied by Diffusion Systems. 11 cm x 6cm samples of film were used for the test

4 Pencil hardness

Pencil hardness was determined according to ASTM D3363 - 74 Standard Test Method for Film hardness by Pencil Test.

5 Surface Friction

Surface friction was determined using a Lloyd JJ T5K "Tensile Tester" available from Instron Ltd. A sample of the film produced in Example 11C was laid on the base plate of the instrument with the surface textured coating face down and a sample of the film to be tested was secured, with surface textured coating face down, to the underside of a block weighing 5.88N. The block was placed on the sample of the film on the base plate. A wire was attached to the block and the Tensile Tester was operated at a cross-head speed of 50mm/minute. The force on the wire required to move the block was measured by the load cell to give a static and a dynamic friction reading. The samples of film to be tested were allowed to equilibrate for one hour at a temperature of 20°C and 60% relative humidity.

Example 1

A polyethylene terephthalate film was melt extruded, cast onto a cooled rotating drum and stretched in the direction of extrusion to approximately 3 times its original dimensions. The cooled stretched film was then coated on both surfaces with an aqueous receptive layer composition containing the following ingredients:

Acrylic resin (16% w/w aqueous based latex of methyl methacrylate/ethyl acrylate/methacrylamide : 46/46/8 mole %, with 25% by weight methoxylated melamine-formaldehyde)	18.75 litres
Ludox TM (50% w/w aqueous silica slurry of average particle size approximately 20 nm, supplied by Du Pont)	0.43 litres
Ammonium nitrate (10% w/w aqueous solution)	0.20 litres
Synperonic N (27% w/w aqueous solution of a nonyl phenol ethoxylate, supplied by ICI)	0.50 litres
Demineralised water	to 100 litres

the pH of the mixture being adjusted to 9.0 with dimethylamino ethanol (prior to the addition of the Ludox TM).

The receptive layer coated film was passed into a stenter oven, where the film was dried and stretched in the sideways direction to approximately 3 times its original dimensions. The biaxially stretched coated film was heat set at a temperature of about 200°C by conventional means. Final film thickness was 125 μm, with a dry coat weight of approximately 0.3 $mgdm^{-2}$.

One of the receptive layers was then coated by hand, using a Meier bar, with the following coating composition:-

Zinc diacrylate (supplied by Röhm Gmbh)	21.0% w/w
Gafgard 233 (by weight approximately 80% pentaerythritol pentaacrylate and 20% N-vinyl pyrrolidone, supplied by GAF)	57.0% w/w
Irgacure 651 (2,2-dimethoxy-2-phenyl acetophenone, supplied by Ciba Geigy)	1.0% w/w
Methanol	21.0% w/w

The applied wet coating was approximately 12 μm thick and was dried in an oven at 100°C for 1 minute. The dried coating was cured by one pass of the film at 2 metres per minute (mpm) under a focused 80 W/cm medium pressure mercury arc lamp (Primarc 'Mini-cure' unit) in air.

The cured film displays surface texture and is suitable for use as an anti-glare coated film for membrane touch switch applications. The exposed receptive coating layer promotes adhesion to graphics inks which can be viewed through the substrate and textured coating layer.

The coating properties of the cured film were assessed and the results are given in Table 1.

Example 2

The procedure of Example 1 was repeated, with identical substrate and receptive layers, but the textured surface layer was derived from a coating composition comprising:

Zinc diacrylate	11.6% w/w
Sartomer 399 (dipentaerythritol monohydroxy pentaacrylate, supplied by Sartomer)	34.7% w/w
Irgacure 651	1.5% w/w
Methanol	52.2% w/w

The applied wet coating was approximately 6 μm thick and was dried in an oven at 100°C for 1 minute. The dried coating was cured by one pass of the film at 3 mpm under a focused 80 W/cm medium pressure mercury arc lamp (Primarc 'Mini-cure' unit) in air.

The cured film displays surface texture and is suitable for use as a protective coating exhibiting a low haze value.

The coating properties of the cured film were assessed and the results are given in Table 1.

Example 3

The procedure of Example 1 was repeated, except that the substrate was 75 μm thick and the receptive layer was derived from a composition comprising the following components;

Acrylic resin (16% w/w aqueous based latex of methyl methacrylate/ethyl acrylate/methacrylamide : 46/46/8 mole %, with 25% by weight methoxylated melamine-formaldehyde)	3.125 litres
Ludox TM (50% w/w aqueous silica slurry of average particle size approximately 20 nm, supplied by Du Pont)	0.43 litres
Ammonium nitrate (10% w/w aqueous solution)	0.20 litres
Synperonic N (27% w/w aqueous solution of a nonyl phenol ethoxylate, supplied by ICI)	0.50 litres
Demineralised water	to 100 litres

the pH of the mixture being adjusted to 9.0 with dimethylamino ethanol (prior to the addition of the Ludox TM).

The textured surface layer was derived from a coating composition comprising:

Zinc diacrylate	2.1% w/w
Sartomer 399	4.9% w/w
Irgacure 907 (2-methyl-1-((4-methylthio)phenyl))-2-morpholino-propanone-1, supplied by Ciba Geigy)	0.48% w/w
Methanol	92.52% w/w

The applied wet coating was approximately 12 μm thick and was dried in an oven at 80°C for 30 seconds.

The dried coating was cured by one pass of the film at 5 mpm under a focused 80 W/cm medium pressure mercury arc lamp (Primarc 'Mini-cure' unit) in air. The cured coat thickness was approximately 0.7 μm.

The cured film displays surface texture and is suitable for use as a durable low-friction backcoat for flexible data storage media.

The coating properties of the cured film were assessed and the results are given in Table 1.

Example 4

The procedure of Example 3 was repeated, with identical substrate and receptive layers, but the textured surface layer was derived from a coating composition comprising:

Sartomer SR368 (tris(2-hydroxyethyl) isocyanurate triacrylate supplied by Cray Valley Products)	1.0% w/w
Irgacure 907	0.7% w/w
Methanol	98.9% w/w

The applied wet coating was dried in an oven at 125°C for 10 seconds to provide a dry coat weight of approximately 110mg/m^2. The dried coating was cured by one pass of the film at 30 mpm under two focused 300 W/inch (118 W/cm) medium pressure mercury arc lamps (Fusion systems type H) in nitrogen. The cured coat thickness was approximately 0.7 μm.

The film was treated on the uncoated side to provide a subbing layer which rendered the substrate optically smooth and was then further treated by sputter coating with an aluminium alloy to form a reflective surface. This surface was then coated with a dye/binder sensitive layer and then a sub-micron transparent protective overcoat layer.

The protective overcoat layer (30nm thick) was derived from a composition comprising a 0.40%w/v solution of the reactive components in a solvent system comprising the following components;

Reactive Components

Ebecryl 220 (hexafunctional aromatic urethane acrylate available from UCB)	64.5%w/w
Ebecryl 210 (difunctional aromatic urethane acrylate available from UCB)	21.5%w/w
Ebecryl 1360 (silicone acrylate available from UCB)	3.8%w/w
Uvecryl P115 (amino acrylate available from UCB)	3.4%w/w
Irgacure 907 (2-methyl-1-[4-(methylthio)-phenyl]-2-morpholino propanone-1 available from Ciba Geigy)	6.8%w/w

Solvent system

Industrial methylated spirits	75%v/v
Acetone	25%v/v
Diacetone	5%v/v

The cured film displays surface texture and is suitable for use as a durable low-friction backcoat for flexible data storage media.

The coating properties of the cured film were assessed and the results are given in Table 1.

Example 5

The procedure of Example 1 was repeated, with identical substrate and receptive layers, but the textured surface layer was derived from a coating composition comprising:

Zinc diacrylate	34.9% w/w
Gafgard 233	18.4% w/w
Irgacure 651	1.9% w/w
Methanol	44.8%w/w

The applied wet coating was approximately 12 μm thick. The coating, drying and curing conditions were as described in Example 1.

The cured film displays surface texture and is suitable for use as a durable ink/pencil receptive coating for drafting film applications.

The coating properties of the cured film were assessed and the results are given in Table 1.

Example 6

The procedure of Example 1 was repeated with the exception that the textured surface layer was derived from a composition comprising:

Zinc diacrylate	42.3% w/w
Irgacure 651	5.3% w/w
Methanol	52.4% w/w

The applied wet coating was approximately 12 μm thick and the coating, drying and curing conditions were as described in Example 1.

Example 7

The procedure of Example 1 was repeated twice, with identical substrate and receptive layers, but the textured surface layer was derived from the two coating compositions below, firstly, a 5% coating solution (Composition 7A) and, secondly, a 10 % coating solution (Composition 7B). The coating solutions were coated on the receptive layer by hand using a Meier bar, and comprised:

	Composition 7A	Composition 7B
Zinc diacrylate	1.0 % w/w	2.0 % w/w
Plex 6696-0 (an oligomeric acrylate thioether supplied by Röhm)	4.0 % w/w	8.0 % w/w
Irgacure 907	0.35 % w/w	0.7 % w/w
Methanol	94.65 % w/w	89.3 % w/w

The applied wet coating was approximately 12 μm thick in each case and was dried in an oven at 100°C for 1 minute. The dried coatings were cured by one pass of the film at 2 metres per minute (mpm) under a focused 80 W/cm medium pressure mercury arc lamp (Primarc 'Mini-cure' unit) in air.

The coating properties of the cured films were assessed and the results are given in Table 2.

Example 8

The procedure of Example 7 was repeated with identical substrate and textured surface layer to produce two films (5% and 10% coating solutions, Compositions 8A and 8B respectively), with the exception that no receptive layer was applied to the substrate prior to coating with the textured surface layer.

The coating properties of the cured films were assessed and the results are given in Table 2.

Example 9

A polyethylene terephthalate film was melt extruded, cast onto a cooled rotating drum and stretched in the direction of extrusion to approximately 3 times its original dimensions. The uniaxially oriented film was passed into a stenter oven, where the film was dried and stretched in the sideways direction to approximately 3 times its original dimensions. The biaxially stretched film was heat set at a temperature of about 200°C by conventional means. Final film thickness was 100 μm.

The biaxially oriented polyethylene terephthalate film was coated on both sides with a priming mixture of the following components:

p-Chloro-m-cresol	2.5 g
VAGH (copolymer of vinyl chloride/vinyl acetate in a ratio of 90:4 wt %, having a 2.3 wt % hydroxyl content, and a weight average molecular weight of 23,000 - supplied by Union Carbide)	0.5 g
Acetone - added to give a final volume of -	100 ml

After coating, the film was dried in a hot air oven maintained at 100°C to yield a film having a dry coat thickness for each receptive layer of approximately 0.2 μm.

The pre-treated polyethylene terephthalate film was then coated on one side by hand, using a Meier bar, with the coating compositions used in Example 7 to produce two films.

The coating, drying and curing conditions were as described in Example 1.

The coating properties of the cured films were assessed and the results are given in Table 2.

Example 10

The procedure of Example 1 was repeated with identical substrate and receptive layers, but the textured surface layer was derived from a coating composition which contained an amorphous silica nucleating agent which was introduced into the composition by high speed dispersing for 15 minutes. The coating compositions comprised:

Aerosil TT600 (an amorphous silica having an average primary particle size of 22 nm and a specific surface area of 200m²/g, supplied by Degussa)	1.5 % w/w
Zinc diacrylate	8.0 % w/w
Plex 6696-0	35.0 % w/w
Irgacure 651	2.6 % w/w
Methanol	52.9 % w/w

The applied wet coating was approximately 12 μm thick. The coating, drying and curing conditions were as described in Example 1.

The cured films display surface texture and are suitable for use as anti-glare coated films for membrane touch switch applications. The exposed receptive coating layer promotes adhesion to graphics inks which can be viewed through the substrate and textured coating layer.

The coating properties of the cured film were assessed and the results are given in Table 3.

Example 11

The procedure of Example 3 was repeated but the texture surface layer was derived from a coating composition containing a nucleating agent, Printex XE2, which was incorporated into the composition by high speed dispersing for 60 minutes. The composition comprised the following components;

Printex XE2 (carbon black having a specific surface area of 1000m²/g and a pH value of 8, supplied by Degussa)	2.0 % w/w
Zinc diacrylate	3.0 % w/w
Plex 6696-0	8.5 % w/w
Sartomer 399	8.5 % w/w
Irgacure 907	1.4 % w/w
Methanol	76.6 % w/w

The applied wet coating was approximately 12 μm thick and was dried in an oven at 100°C for 1 minute. The dried coating was cured by one pass of the film at 2 metres per minute (mpm) under a focused 80 W/cm

medium pressure mercury arc lamp (Primarc 'Mini-cure' unit) in air.

The coating properties of the cured film was assessed and the results are given in Table 3.

Example 12

The procedure of Example 3 was repeated with the substrate and receptive layers providing a film thickness of 75 μm, with a dry coat weight of approximately 0.3 mgdm^{-2}, but the textured surface layer was derived from coating compositions 12A to 12G as indicated below and was applied to the receptive layer by "bead" (meniscus) coating;

	Composition (% w/w)								
	12A	12B	12C	12D	12E	12F	12G	12H	12J
Plex 6696-0	-	-	-	-	-	4.25	8.5	3.8	3.8
Sartomer 399	1.3	3.26	5.21	7.16	9.12	4.25	8.5	3.8	3.8
Zinc diacrylate	0.56	1.4	2.23	3.07	3.90	1.50	3.0	1.35	1.35
Irgacure 907	0.14	0.35	0.56	0.77	0.98	0.70	1.4	0.65	0.65
Methanol	98.0	95.0	92.0	89.0	86.0	89.3	78.6	45.2	18.1
Tetrahydrofuran	-	-	-	-	-	-	-	45.2	-
Acetone	-	-	-	-	-	-	-	-	72.3
Total % w/w solids	2.0	5.0	8.0	11.0	14.0	10.7	21.4	9.6	9.6

The applied wet coating was approximately 12 μm thick and was dried in an oven at 100°C for a period up to 20 seconds (12A to 12G) and at 125°C for 10 seconds and 20seconds for 12H and 12J respectively,. The dried coating was cured by one pass of the film at 24 metres per minute (mpm) for Examples 12A to 12E, 30 mpm for Example 12F and 12H, 20 mpm for Example 12G and 15 mpm for Example 12J under a pair of focused 118 W/cm (300 W/inch) UV lamps (microwave generated type H bulb Fusion Systems) in a nitrogen purged atmosphere.

Films 12C, 12F and 12G were treated on the uncoated side of the film with a coating composition the same as the overcoat coating composition in Example 4 except that the composition comprised a 3.75%w/v solution of the reactive components in the solvent system to provide a coating of 220nm thickness.

A second sample of film 12F was prepared, and was coded as 12F (thin). Film 12F (thin) was prepared by the same procedure as films 12C, 12F and 12G except that the sub-micron transparent protective overcoat layer was 30nm thick.

The coating properties of the cured films were assessed and the results are given in Table 4.

Example 13

The procedure of Example 3 was repeated with the substrate and receptive layers providing a film thickness

of 75 μm, with a dry coat weight of approximately 1200 mgm^{-2}, but the textured surface layer was derived from coating compositions 13A to 13C as indicated below and was applied to the receptive layer by "bead" (meniscus) coating;

	Composition(%w/w)		
	13A	13B	13C
Chromium triacrylate	0.30	-	-
Zirconium tetraacrylate		-	0.45
Lead(II) diacrylate	-	-	0.75
Sartomer 399	3.8	3.8	3.8
Plex 6696-0	3.8	3.8	3.8
Irgacure 907	0.63	0.63	0.63
Methanol	91.47	91.32	91.02
Total % w/w solids	8.53	8.68	8.98

Two films for each of coatings 13A, 13B and 13C were produced and differed only in the time of drying of the coating (air impingement) and in the UV curing line speed (using a pair of focused 118 W/cm (300 W/inch) UV lamps (microwave generated type H bulb Fusion Systems) in a nitrogen purged atmosphere) as listed below;

	13A	13A'	13B	13B'	13C	13C'
Drying Time (seconds)	30	20	60	30	60	10
UV cure (line speed)	10	15	5	10	5	30

All of the films in this Example were treated on the uncoated side of the film to provide a coating identical to that described in Example 4. The coating properties of the cured films were assessed and are shown in Table 4.

Example 14

A biaxially oriented polyester terephthalate substrate film (obtained from Toray) of 6μm thickness was coated with the following composition to provide a wet coat thickness of 13μm;
Zinc diacrylate 2.23 %w/w

Sartomer 399	5.21 %w/w
Irgacure 907	0.56 %w/w
Methanol	92.0 %w/w

The coat was applied by a "bead" (meniscus) coating directly onto the substrate and dried at 100°C for 12 seconds. The coating was then cured by passing the film under a medium pressure 120W/cm mercury arc lamp at 24 mpm in a nitrogen purged atmosphere.

A second coating of wet coat thickness 12μm was then applied using a Meier bar on top the first coating and was derived from the following composition;

Zinc diacrylate	1.00 %w/w
Irgacure 907	0.07 %w/w
Methanol	98.93%w/w

The second coating was dried in an oven at 90°C for 30 seconds and cured by being exposed to a single 80W/cm medium pressure mercury arc lamp at 7 mpm.

The film was suitable for use as a substrate with back coat for a thermal transfer printing dye sheet. The surface roughness of the surface textured film produced was measured and is listed below. The handling characteristics of the film were evaluated by processing the film through a thermal transfer printer (Hitachi VY200) and recording any creasing or fusing of the film with the thermal print head.

Results

The film produced in this Example had the following surface characteristics;

Ra : 1.2μm

Rsm: 200μm

On passing through the printer, the film did not show any visible evidence of fusing or creasing. This evaluation clearly demonstrated that the back coat of the film possessed good thermal stability (no fusing) and friction characteristics (no creasing) and was therefore suitable for use as a back coat for a thermal transfer dye sheet.

Example 15

The procedure of Example 12 was repeated to produce a film identical to that of Example 12F with the exception that the surface texture coating solution contained 9.6% w/w total solids (the components of the coating solution being present in the same relative amounts as those in Example 12F) and the coating was dried in two stages, the first at 125°C for 6 seconds and the second at about 85°C for 5 seconds. The coating was cured in the same way as in Example 12F.

The cured coating was then coated with a low surface energy supercoat consisting of a 0.05%w/v formulation of Carnauba wax (available from Hopkin and Williams) in "Genklene" (1,1,1-trichloroethane available from ICI) by a "bead" (meniscus) technique to give a wet coat weight of 13gm^{-2}. The supercoat was then dried at 80°C for 18 seconds.

The film produced possessed surface roughness (Ra 0.66μm and Rsm 180μm) and a static coefficient of friction of 0.31. The surface energy of the film was determined according to ASTM D 2578-67 as being less than 36 dyne cm^{-1}.

Example 16

This is a comparative Example not according to the invention. The surface texture of the film produced in this Example was provided by a conventional mineral filler (alumina hydrate) and was not due to the acrylate monomer to any significant extent. The avoidance of the monomer forming surface texture was due to the incorporation of a relatively high boiling solvent (diacetone alcohol) in the coating composition.

The procedure of Example 12 was repeated with identical substrate and receptive layers and the coating composition comprised ;

Ebecryl 600 (a difunctional epoxy acrylate oligomer supplied by UCB)	7.06 % w/w
Alumina hydrate	0.05 % w/w
Irgacure 907	0.28 % w/w
Quantacure ITX (a mixture of 2-isopropyl and 4-isopropyl thioxanthones supplied by International Bio Synthetics (IBS))	0.14 % w/w
Quantacure EPD (ethyl 4-(dimethylamino)benzoate supplied by IBS)	0.14 % w/w
Uvecryl P115 (an amino acrylate supplied by UCB)	0.28 % w/w
Cellulose acetate	0.024% w/w
Diethyl orthophthalate	0.024% w/w
Acetone	69.0 % w/w
Methanol	18.4 % w/w
Diacetone alcohol	4.6 % w/w

The coating, drying and curing conditions were the same as in Example 12. The film was treated on the uncoated side using the same procedure as that used to treat the uncoated side of the film produced in Example 4. The coating properties of the film were assessed and the results are given in TABLE 4.

Example 17

This is a comparative Example not according to the invention. The procedure of Example 12 was repeated with identical substrate and receptive layers but the textured surface layer was derived from a coating of the following composition and contained a conventional mineral filler (silica). The coating composition was formed by dispersing Aerosil R972 into a mill base formulation by bead milling for 40 mins to provide a mill base composition comprising

Ebecryl 5129	29.93 % w/w
Isopropyl alcohol	29.93 % w/w
Methanol	29.93 % w/w
Aerosil R972	9.99 % w/w

Isocetyl stearate 0.23 % w/w

The mill base composition was then slowly diluted with other components to provide the coating composition which comprised:

Ebecryl 5129 (a hexafunctional aliphatic urethane acrylate supplied by UCB)	10.0 % w/w
Aerosil R972 (a hydrophobic surface treated silica having an average primary particle size of 16 nm and a BET surface area of 110 ± 20 m^2/g, supplied by Degussa)	1.0 % w/w
Isocetyl stearate	0.02 % w/w
Irgacure 907	0.4 % w/w
Uvecryl P115 (An amino-acrylate co-initiator supplied by UCB)	0.4 % w/w
Isopropyl alcohol	3.0 % w/w
Acetone	61.83 % w/w
Methanol	19.25 % w/w
Diacetone alcohol	4.1 % w/w

The applied wet coat was approximately 12 μm thick and was dried in an oven at 80°C for 40 seconds. The dried coating was cured by one pass of the film at 10 metres per minute (mpm) under a pair of focused 118 W/cm (300 W/inch) W lamps (microwave generated type H bulb Fusion Systems) in a nitrogen purged atmosphere.

The film was treated on the uncoated side using the same procedure as that used to treat the uncoated side of film 12F (thin) produced in Example 12.

The coating properties of the cured film were assessed and the results are given in Table 4.

Example 18

Film 12C produced in Example 12 and the film produced in Example 16 (comparative) were evaluated as optical data storage tape medium.

A sample of the two films was slit into 35mm tapes and the treated films 12C and 16 (comparative) were spliced together to form a composite tape.

The composite tape was subjected to 10000 reeling cycles at 500m/min under a tension of 6 Newtons and then visually inspected for wear and damage to the aluminium alloy-dye/binder-overcoat surface.

Results

The overcoat of the film produced in Example 16 exhibited a large number of scratches and scuffing damage.

The overcoat of film 12C showed no signs of significant wear or damage thus demonstrating that a surface textured film of the invention provides significant improvement as regards resistance to wear and damage as compared with a conventionally coated film of the prior art.

Example 19

The film produced in Example 4 and film 12F (thin) produced in Example 12 and the film produced in Example 17 (comparative) were evaluated as an optical data storage tape medium.

A sample of the films was then slit into 35mm tapes.

The wear characteristics of the films were assessed by subjecting the tapes to multiple cycling in which a pre-written portion of the tape was wound backwards and forwards between two spools at a speed of 3 m/s using the transport mechanism of a Creo Products 1003 Optical Tape Recorder.

Wear damage was determined by measuring the bit error rate (BER) of the tapes at intervals during the cycling procedure. The BER provides a measure of the ratio of damaged data bits to the number of initially recorded data bits.

The results of these tests are given in TABLE 5 and illustrated by Figure 4. The test on the film of Example 17 was abandoned after 10000 cycles due to unacceptably high error rates whilst film 4 and film 12F provided only low error rates even after more than 50000 and 60000 cycles respectively.

The initial BER value for the film of Example 4 was significantly lower than that for Examples 12F and 17 due to the subbing layer providing an optically smooth surface onto which the Aluminium was sputtered.

TABLE 1

Example	Adhesion	Surface Roughness		Optical Properties			Pencil
		Ra(μm)	Rsm(μm)	Haze(%)	TLT(%)	Gloss	Hardness
1	0/8	2.2	190	54	91.4	28	-
2	0/8	0.85	286	8.8	92.0	73	8H
3	0/8	0.35	115	-	-	-	-
4	0/8	0.07	<36	-	-	-	-
5	0/8	1.7	108	65	89.1	21	6H
6A	0/8	0.13	30	-	-	-	-
6B(6μm wet coat)	0/8	0.06	200	89.7	1.2	-	-
6B(12μm wet coat)	0/8	0.36	266	89.9	1.3	-	-
6B(24μm wet coat)	0/8	1.05	500	90.3	3.4	-	-

Examples 1 to 6 demonstrate that films of the present invention may possess a wide variety of combinations of surface roughness and optical characteristics.

TABLE 2

Example	Adhesion	Surface Roughness	
		Ra(μm)	Rsm(μm)
7A	0/9	0.30	68
7B	0/9	0.53	109
8A	0/9	0.27	74
8B	0/9	0.48	114
9A	0/9	0.31	81
9B	0/9	0.47	122

Examples 7 to 9 demonstrate that the surface textured coatings disclosed herein may be applied to a variety of receptive layers or directly onto the untreated substrate and provide provide desirable surface roughness characteristics without there being any drawbacks due. to lack of adhesion between the textured coating and the substrate or receptive layer.

TABLE 3

Example	Adhesion	Surface Roughness		Optical Properties	
		Ra(μm)	Rsm(μm)	Haze(%)	TLT(%)
10	0/9	0.34	63	18.3	91.9
11	0/9	0.74	20	71.5	52.6

Examples 10 and 11 demonstrate that a wide variation in optical properties may be secured together with desirable surface roughness characteristics when a nucleating agent is included in the coating composition.

TABLE 4

Example	%w/w Solid	Surface Roughness		Friction Coefficient	
		Ra	Rsm	Static	Dynamic
12A	2	0.13	64	0.96	0.18
12B	5	0.30	81	0.61	0.13
12C	8	0.45	99	0.87	0.15
12D	11	0.59	127	0.81	0.16
12E	14	0.83	166	0.95	0.19
12F	10.7	0.46	208	0.23	0.24
12F(thin)	10.7	0.43	190	2.45	2.15
12G	21.4	0.51	250	0.23	0.22
12H	9.6	0.48	154	>0.85	-
12J	9.6	0.30	133	>0.85	-
13A	8.53	0.13	84	0.64	-
13A'	8.53	0.13	119	0.56	-
13B	8.68	0.14	52	>0.85	-
13B'	8.68	0.10	70	>0.85	-
13C	8.98	0.27	9	>0.85	-
13C'	8.98	0.26	123	0.54	-
16comparative)				0.15	0.13
17(comparative)		0.09		0.58	0.41

Examples 12A, 12B, 12C, 12D, 12E, 12F and 12G illustrate that substantially similar dynamic friction characteristics may be secured with films having a wide variety of solids content. Examples 12 H and 12J illustrate that similar surface roughness characteristics may be obtained when a particular coating is applied from a variety of solvent systems. Examples 13A to 13C′ illustrate that a variety of metal acrylates provide a desirable combination of surface roughness (Ra) and static friction.

TABLE 5

Cycles	BER/10^{-4}		
	Example 4	Example 12F (thin)	Example 17
0	0.081	6.04	6.86
100	0.149	-	8.54
200	0.176	-	9.47
300	0.200	-	10.4
400	0.231	-	11.4
500	0.256	6.17	11.8
600	0.272	-	12.3
700	0.291	-	12.8
800	0.310	-	13.6
1000	0.334	6.18	14.4
1500	0.401	6.14	15.8
2000	0.449	6.27	16.5
2500	0.505	6.19	17.6
3000	0.546	6.17	18.5
3500	0.592	6.05	19.0
4000	0.635	6.05	19.6
4500	0.691	6.19	19.8
5000	0.745	6.19	20.3
5500	0.814	6.22	20.6
6000	0.865	6.08	21.1
6500	0.923	6.32	21.5
7000	0.988	6.20	21.8
7500	1.04	6.28	22.1
8000	1.11	6.35	22.5
8500	1.17	6.10	22.9
9000	1.23	6.30	23.6
9500	1.28	6.24	24.0
10000	1.32	6.27	24.4
20000	2.67	6.41	-
30000	3.80(at 28000)	6.61	-
40000		6.67	-
50000		6.50	-
60000		6.84	-

Claims

1. A surface textured film comprising a polymeric substrate having on at least one surface thereof a surface textured coating comprising a cured material comprising at least one polymer wherein the surface texture is imparted primarily by the polymer or polymers per se and wherein the substrate is not oriented after the coating is formed.

2. A surface textured film comprising a polymeric substrate having on at least one surface thereof a surface textured coating comprising a cured material comprising at least one polymer wherein the surface texture is imparted primarily by the polymer or polymers per se and the film has an average surface roughness (Ra) of at least 0.05 μm.

3. A surface textured film comprising a polymeric substrate having on at least one surface thereof a surface textured coating comprising a cured material comprising at least one polymerised component wherein the surface texture of the coating is induced at least in part as a result of evaporation of a volatile vehicle from a coating composition comprising the said volatile vehicle and the unpolymerised component(s).

4. A surface textured film comprising a polymeric substrate having on at least one surface thereof a surface textured coating comprising a cured material comprising at least one multi-functional (meth)acrylate ester polymer wherein the surface texture is imparted primarily by the polymer or polymers per se.

5. A film according to claim 4 in which the multifunctional (meth)acrylate ester polymer is present in an amount of at least 1% by weight based on the cured components in the coating.

6. A film according to claim 4 or 5 in which at least 10% of the available (meth)acrylate double bonds present in the uncured coating are converted to single bonds by curing the coating.

7. A film according to any preceding claim in which the polymer or polymerised component of the surface textured coating comprises a metal (meth)acrylate.

8. A film according to any preceding claim further comprising a supercoat on the surface textured coating, the supercoat having a low surface energy.

9. A dyesheet for thermal transfer printing which comprises a surface textured film as defined in any preceding claim having the surface textured coating on one surface of the substrate and having a dye layer on the other surface of the substrate.

10. A method of producing a surface texture film which comprises coating a polymeric substrate with a solution or dispersion of a material in a volatile vehicle, drying the coating to remove at least part of the volatile vehicle, the material comprising at least one polymerisable component such that the drying process is effective to impart a surface texture to the dried layer formed by the coating of material, and curing the dried layer.

Fig.1

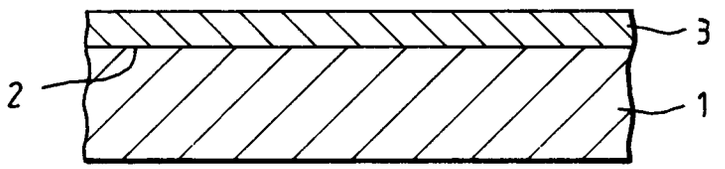


Fig.2

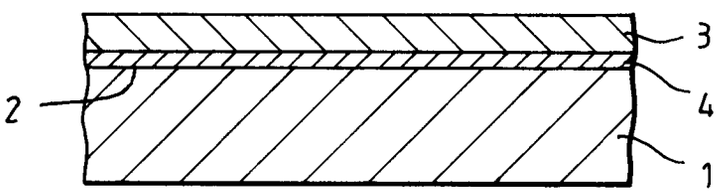


Fig.3

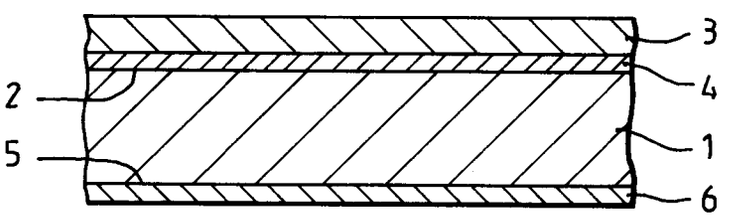
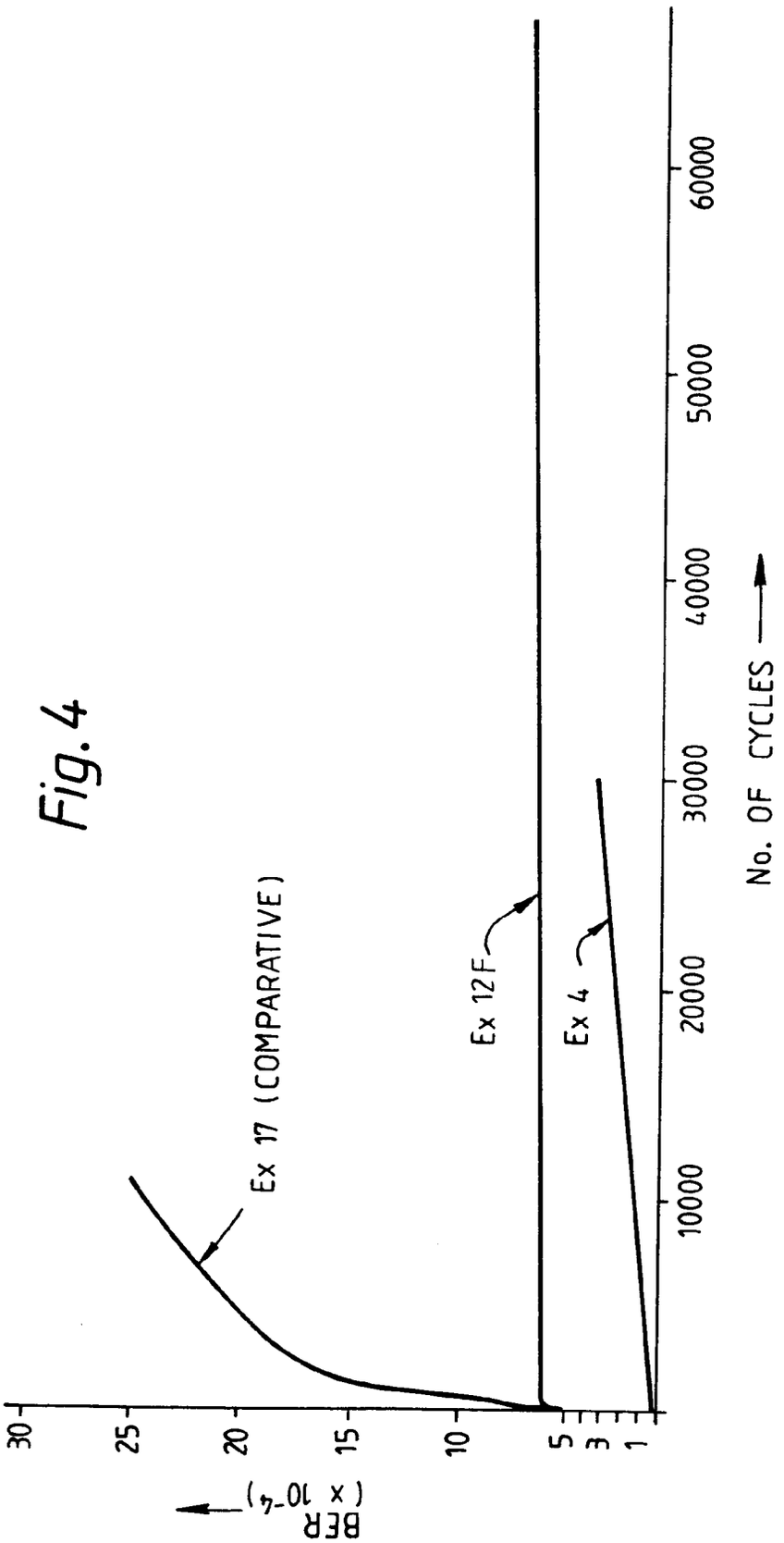


Fig. 4


BER
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15
10
5
3
1
10000
20000
30000
40000
50000
60000
No. OF CYCLES
Ex 17 (COMPARATIVE)
Ex 12F
Ex 4