

PRESSURE SENSITIVE ADHESIVES FOR USE WITH DATA STORAGE DEVICES

This invention relates to computer devices. More particularly, this invention relates to pressure sensitive adhesives (PSA) for use with computer devices, and to methods for preparing cleaner computer devices, such as cleaner data storage devices.

Computer disk drives are complex assemblages of surface treated alloys, plastics, elastomeric, and ceramic parts containing various lubricants and a variety of adhesives. Pressure sensitive adhesives are used for various applications such as seals, labels, damping, etc. in today's computer data storage devices. The use of PSA's has been an effective means of lowering unit cost for storage devices. A typical drive may include at least one component which bears a PSA, e.g., a tape, which is used to hold the housing of the disk drive together.

Demand for increased storage capacity of disk drives has produced product designs requiring a higher level of concern for adhesive contamination. New disk drive technology, such as decreasing flying heights, using magneto-resistive head technology, and pseudo-contact recording, have improved the performance and capacity of disk drive components. Use of this new technology has also left the disk drive more susceptible to damage from environmental factors. Building drives with contaminated or outgas-prone parts can result in stiction/wear and functional problems, including electrical error issues from thermal asperities.

The cleanliness of PSA materials has been a concern for disk drive engineers. Physical contamination such as dust particles, skin flake, and moisture, along with possible chemical contamination by the materials used in the PSA, can affect the drive

life or reliability of the device. Adhesive materials can deposit contaminants on disk and reading heads and cause reading problems or disk crashes.

Specific ions and organic tins are particularly harmful to heads and disks. Small levels of chlorine containing materials have been identified to be responsible for disk corrosion. Organic materials capable of undergoing polymerization are unacceptable at very low levels. Organic or inorganic acids or bases can corrode the sensitive layers of the storage disk. Typical types of microcontamination commonly found in the disk drive industry include organic contamination that can cause stiction; corrosion from residual anions (particularly, chloride and sulfate ions); outgassing, which can result in stiction; and airborne particulates.

Polyacrylate-based PSA's have been used extensively in the components for disk drives. A select few are considered useable; none are totally satisfactory. The chemical byproducts from the initiators used in the initial polymerization of acrylates can be unacceptable even at relatively low levels in disk drives. The solvents and their impurities used to dissolve and coat polyacrylate PSA's can be a problem if not thoroughly dried from the finished adhesive coating. Most polyacrylate pressure sensitive adhesives must be chemically cross-linked to provide the necessary performance characteristics. The chemicals used for, or byproducts produced from, the cross-linking can be unacceptable or at unacceptable levels. The levels of unreactive monomers and their impurities in polyacrylate PSA's have been known to cause drive failures.

The disk drive industry is resorting to two strategies in order to minimize the presence of microcontaminants in the environment of the disk drive. The first strategy is to use one of a variety of cleaning methods in order to remove the microcontaminants

from the finished disk drive parts. Typically, such cleaning methods are either aqueous cleaning, solvent cleaning, or carbon dioxide cleaning. All of these cleaning methods have their advantages and difficulties. However, no cleaning method can remove all contaminants. Cleaning is a percentage removal process, and it targets specific
5 contaminants. The higher the initial level of contaminants, the higher the final level of contaminants in the finished product.

The second strategy used by the disk drive industry is to use parts and processes that contain or produce fewer contaminants. These more stringent specification requirements are a challenge to the suppliers of components for the disk drive industry.
10 Specific requirements include low outgassing and low ionic contamination. For example, a typical limit for outgassed materials may be as low as 2500 nanograms per square centimeter (ng/cm^2); the limit for anions may be a maximum of 800 ng/cm^2 .

Further disclosure on microcontaminants in the disk drive industry can be found in Peter Mee et al, Management of Disk Drive Component Microcontamination, IDEMA®
15 Insite, Vol. IX, No. 2 (March/April 1997).

It has been a difficult challenge for the adhesive industry to meet the requirements of the disk drive engineers with polyacrylate adhesives. This invention relates to a method for preparing a computer device in a manner that a lower level of microcontaminants is present around the disk drive.

20 Hydrogenated styrene-elastomer-styrene block copolymer or a hydrogenated styrene-elastomer-styrene-elastomer block polymer in combination with certain "clean" or "cleanable" tackifying resins are formulated into a liquid coating, coated and properly dried on an acceptable substrate. The component, e.g., a tape, label, seal, etc., thus

produced is ideally suited for use in disk drives. The component produced in this manner, has a much lower total aggregate concentration of materials considered harmful by the industry, compared to most polyacrylate adhesive components of the same design.

In one embodiment, the invention comprises an improved method for preparing a computer device which includes at least one component bearing a PSA, the method comprising applying an improved PSA to the PSA bearing component, wherein the improved PSA comprises:

- A. at least one of a hydrogenated styrene-elastomer-styrene block copolymer or a hydrogenated styrene-elastomer-styrene-elastomer block copolymer, and
- B. at least one tackifying resin.

In another embodiment, the invention comprises a computer device comprising at least one component containing a PSA comprising:

- A. at least one of a hydrogenated styrene-elastomer-styrene block copolymer or a hydrogenated styrene-elastomer-styrene-elastomer block copolymer, and
- B. at least one tackifying resin.

A "block copolymer" is a polymer containing long stretches of two or more monomeric units linked together by chemical valences in one single chain, such that the long monomeric stretches alternate with each other. A "diblock copolymer" is a block copolymer that has the general structure A-B, where A is a long stretch of one copolymer and B is a long stretch of a second copolymer. A "triblock copolymer" is a block

copolymer that has the general structure A-B-A, where A is a long stretch of one copolymer and B is a long stretch of a second copolymer.

A "tackifying resin" is a resin that, when added to a rubber or an elastomer, the resulting composition has the properties of a pressure sensitive adhesive. "Pressure sensitive adhesives" are permanently and aggressively tacky (sticky) solids which form immediate bonds when two parts are brought together under pressure. For pressure sensitive adhesives, "tack" can be described as the property whereby the adhesive will adhere tenaciously to any surface with which it comes into contact under light pressure. The strength of the bond will be greater under increasing pressure, hence the term pressure sensitive. Tack can be quantified as the force required to separate an adherend and an adhesive at the interface shortly after they have been brought rapidly into contact under a light load of short duration. Tack can be measured by using the ASTM D-2979 procedure.

A "hydrocarbon resin" is a resin in the number molecular weight range of a few hundred up to about 6,000 or 8,000, which is obtained or synthesized from rather basic hydrocarbonaceous materials such as petroleum, coal, tar, turpentine, and the like.

An improved computer device is prepared by preparing at least one adhesive as described below and affixing the adhesive to at least one component of the computer device. Preferably, the component is a film, tape or label which is used to seal or identify one or more components of the computer device. The computer device is preferably a disk drive or other data storage device.

The Adhesive

The adhesive used in this invention comprises at least about 10, preferably at least about 40, up to about 90, preferably up to about 75, weight percent of a block copolymer and at least about 10, preferably at least about 25, up to about 90, preferably up to about 60, weight percent of a tackifying resin, all percentages based on the total weight of the adhesive.

Block Copolymers

Any one of the variety of well-known block copolymers can be included within the composition of this invention, including those described in some detail within U.S.P. 3,239,478 and 3,917,607, both of which are incorporated herein by reference. These particular block copolymers typically take on the general configuration A-B-A or A-B-A-B, wherein each "A" block, which is generally characterized as an end block, is a thermoplastic polymer block prepared by a polymerization of a mono-alkenyl-arene such as styrene, α -methyl-styrene, tert-butyl-styrene, and vinyl-toluene.

The elastomer "B" blocks, which are characteristically identified as "mid blocks," are prepared by the propagation of a polymer chain of a conjugated diene such as butadiene or isoprene from the end of the end block already synthesized. Then either using sequential monomer addition or a coupling agent, the desired block copolymers, A-B-A or A-B-A-B, are generated. If the block copolymers, A-B-A or A-B-A-B are hydrogenated, a saturated mid block would be obtained. Such block copolymers, which are prepared by known procedures, include styrene-butadiene-styrene block copolymer (SBS), styrene-isoprene-styrene block copolymer (SIS), styrene-ethylene butylene-styrene block copolymer (SEBS), styrene-ethylene propylene-styrene (SEPS), and a-

methylstyrene-ethylene propylene-a-methylstyrene. A typical molecular weight for such block copolymers is between about 10,000 and about 500,000, expressed as number average molecular weight.

Preferably, the block copolymer of this invention is a hydrogenated block copolymer. Hydrogenation minimizes the presence of double or triple bonds in potentially outgassed materials that could result in those outgassed materials polymerizing on the computer device components. Such polymerization can interfere with the recording, storage or reading of data in a computer data storage device.

The hydrogenated block copolymer is preferably a block copolymer of polystyrene and a polydiene, the polydiene typically selected from the group consisting of polybutadiene and polyisoprene, wherein the unsaturated mid block of either polybutadiene or polyisoprene is hydrogenated to yield a saturated mid block. The saturated mid block of the hydrogenated block copolymer has the structure of poly(ethylene-propylene), poly(ethylene-butylene), or both.

More preferably, the block copolymers of this invention comprise styrene end blocks and hydrogenated polybutadiene and/or hydrogenated polyisoprene mid blocks. Such block copolymers are also disclosed in U.S.P. 4,136,699; 4,361,672; 4,460,364; 4,714,749; and 5,459,193, all incorporated herein by reference, and in KRATON® Thermoplastic Rubbers published by Shell Chemical Company.

Most preferably, the block copolymer has end blocks of styrene whose number average molecular weight is in the range of 10,000 to 30,000, and the mid block is a block of hydrogenated polyisoprene having a number average molecular weight of about 125,000. Such hydrogenated block copolymers are known as styrene-ethylene-propylene-

styrene (SEPS) copolymers. Such block copolymers are commercially available from the Shell Chemical Company under the trademark KRATON® G.

The KRATON® G hydrogenated block copolymers have a number average molecular weight (M_n) of about 25,000 to about 300,000, as measured by gel permeation chromatography (GPC). Among the KRATON® G polymers, the most preferred are KRATON® G1650, KRATON® G1652, KRATON® G1654, KRATON® G1657, and KRATON® G1730, or a combination thereof. More information on KRATON® G polymers is disclosed in KRATON® Polymers for Adhesives and Sealants, available from Shell Chemical Company.

In one embodiment of the invention, the block copolymer is a "clean block copolymer". A clean block copolymer contains no more than about 200, preferably less than about 100, more preferably less than about 50, ng/cm² of bromide, chloride, fluoride, nitrate, nitrite, phosphate and sulfate anions combined, and less than about 200, preferably less than about 100, more preferably less than about 50, ng/cm² of ammonium, as measured by Modified EPA Method 300.0 Revision 2.1 (described later). Additionally, a clean block copolymer, in combination with the tackifying resin(s), outgasses less than 1500 ng/cm² as measured by Modified IDEMA M11-98 (described later).

In another embodiment of the invention, the block copolymer is a "cleanable block copolymer." A cleanable block copolymer contains more outgassable contaminants and anions than does a clean block copolymer, but the outgassable contaminants and anions can be substantially removed, through removal means, such that the levels of the remaining outgassable contaminants and anions are no greater than for a clean block

copolymer. Such removal means can comprise extreme high temperature drying, spray drying, aqueous cleaning, solvent cleaning, or CO₂ cleaning. For practical reasons, aqueous cleaning is the preferred means for ion removal.

Tackifying Resins

5 Tackifying resins of this invention are resins that associate predominantly with the elastomeric block or mid block and are substantially incompatible with nonelastomeric or end blocks. These mid block associating resins are compatible with the mid block in that between about 100 and about 200 or more parts by weight of the mid block associating resin show a clear film when the particular mid block associating resin is combined with
10 100 parts of the mid block of the block copolymer and cast from solution in toluene.

 In one embodiment of this invention, the tackifying resins usable in this invention must be "clean". A "clean tackifying resin" contains no more than about 200, preferably less than about 100, more preferably less than about 50, ng/cm² of bromide, chloride, fluoride, nitrate, nitrite, phosphate and sulfate anions combined, and less than about 200,
15 preferably less than about 100, more preferably less than about 50, ng/cm² of ammonium, as measured by Modified EPA Method 300.0 Revision 2.1 (described later). Additionally, a clean tackifying resin, in combination with the block copolymer(s), outgasses less than 1500 ng/cm² as measured by Modified IDEMA M11-98 (described later).

 In another embodiment of the invention, the tackifying resin is a "cleanable
20 tackifying resin." A cleanable tackifying resin contains more outgassable contaminants and anions than does a clean tackifying resin, but the contaminants can be substantially removed, through removal means, such that the levels of remaining contaminants are no greater than for a clean tackifying resin. Such removal means can comprise extreme high

temperature drying, spray drying, aqueous cleaning, solvent cleaning, or CO₂ cleaning.

For practical reasons, aqueous cleaning is the preferred means for ion removal.

Examples of tackifying resins that may be useful in this invention include polyhydric esters of rosin or hydrogenated rosin esters, such as glycerol and pentaerythritol esters of hydrogenated rosins and of highly stabilized rosins, esters of polyhydric alcohol, synthetic polyterpenes, terpene-olefin copolymers, terpene-phenols, tall oil rosin, synthetic saturated hydrocarbon resins, such as saturated alicyclic hydrocarbons, olefinic resins, aromatic containing resins, phenol-aldehyde resins, α -pinene resins, β -pinene resins, terpene-phenolic resins, and copolymers such as of 1,3-pentadiene and 2-methyl-2-butene, or mixtures thereof. Other examples of tackifying resins are disclosed in U.S.P. 4,361,663 and 4,399,249, both incorporated herein by reference, and in U.S.P. 4,136,699; 4,361,672; 4,714,749; and 5,459,193.

The preferred tackifying resin of this invention is of the type known as "hydrocarbon resins". A good description of hydrocarbon resins can be found in Kirk-Othmer, Encyclopedia of Chemical Technology, Second Edition, Vol. 11, Interscience, New York, 1966, pg. 242. Many of the so-called hydrocarbon resins commercially available today are terpene resins, i.e., polymers with (repeating) isoprene (C₅H₈) or C₁₀H₁₆ units. These polymers can be natural or synthetic and can be copolymers (including terpolymers, etc.), since isoprene is an olefin which can be copolymerized with other olefins. Terpene-phenols are also produced.

Aromatic monomers useful in forming the aromatic containing resin compositions of this invention can be prepared from any monomer containing substantial aromatic qualities and a polymerizable unsaturated group. Typical examples of such aromatic

monomers include: styrenic monomers, e.g., styrene, α -methylstyrene, vinyl toluene, methoxy styrene, tertiary butyl styrene, chlorostyrene, etc.; indene monomers including indene, methyl indene and others. Aliphatic monomers are typically natural and synthetic terpenes which contain C_6 and C_5 cyclohexyl or cyclopentyl saturated groups that can additionally contain a variety of substantial aromatic ring substituents.

Aliphatic tackifying resins can be made by polymerizing a feed stream containing sufficient aliphatic monomers such that the resulting resin exhibits aliphatic characteristics. Such feed streams can contain other aliphatic unsaturated monomers such as 1,3-butadiene, cis-1,3-pentadiene, trans-1,3-pentadiene, 2-methyl-1,3-butadiene, 2-methyl-2-butene, cyclopentadiene, dicyclopentadiene, terpene monomer, terpene phenolic resins and others. Mixed aliphatic aromatic resins contain sufficient aromatic monomers and sufficient aliphatic monomers to produce a resin having both aliphatic and aromatic character. The article by Davis, "The Chemistry of C_5 Resins," discusses synthetic C_5 resin technology. The preferred tackifying agents are hydrogenated C_5 to C_{12} resins, preferably a C_9 resin.

Representative examples of useful aliphatic resins include hydrogenated synthetic C_9 resins, synthetic branched and unbranched C_5 resins and mixtures thereof. Representative examples of aromatic tackifying resins include styrenated terpene resins, styrenated C_5 resins or mixtures thereof.

Preferably, the tackifying resin is derived by the polymerization and hydrogenation of pure monomer hydrocarbon feed stocks (wherein the hydrocarbon monomer has about 5 or about 9 carbon atoms). Such hydrocarbon resins are highly stable, light colored, low molecular weight, non-polar resins and are suggested for use in

plastics, adhesives, coatings, sealants and caulks. Hydrogenation minimizes the presence of double or triple bonds in potentially outgassed materials that could result in those outgassed materials polymerizing on the computer device components. Such polymerization can interfere with the recording, storage or reading of data in a computer data storage device.

More preferably, the tackifying resin of this invention is low molecular weight nonpolar hydrocarbon resin commercially available under the trademark REGALREZ® from Hercules Incorporated. Most preferably, the tackifying resin is at least one of REGALREZ® 1018, REGALREZ® 1085, REGALREZ® 1094 and REGALREZ® 1126.

Optional Components

The PSA's of this invention can optionally include other components known in the art. These components can include plasticizing oils, resin modifiers, and antioxidants.

A "plasticizing oil", also known as an extending oil, is an organic compound added to a high polymer both to facilitate processing and to increase the flexibility and toughness of the final product by internal modification (solvation) of the polymer molecule. The latter is held together by secondary valence bonds; the plasticizing oil replaces some of these with plasticizing oil-to-polymer bonds, thus aiding movement of the polymer chain segments. Among the more important plasticizing oils are nonvolatile organic liquids and low-melting solids, e.g., phthalate, adipate, and sebacate esters, polyols, such as ethylene glycol and its derivatives, tricresyl phosphate, castor oil, etc.

These optional components tend to be "dirty" in that they contain undesirable ions and/or contribute to outgassing from the PSA. Antioxidants in particular can be harmful

if outgassed into a disk drive system. Therefore, the current preferred embodiments of the invention do not include these optional components. However, the invention contemplates use of these ingredients at levels wherein the PSA containing these ingredients contains no more than about 200, preferably less than about 100, more preferably less than about 50, ng/cm² of bromide, chloride, fluoride, nitrate, nitrite, phosphate and sulfate anions combined, and less than about 200, preferably less than about 100, more preferably less than about 50, ng/cm² of ammonium, as measured by Modified EPA Method 300.0 Revision 2.1 (described later). Additionally, such a PSA outgasses less than 1500 ng/cm² as measured by Modified IDEMA M11-98 (described later).

Method of Forming the PSA

The PSA compositions of hydrogenated block copolymers and tackifying resins can be formed by technologies well known in the art, such as the technologies disclosed in U.S.P. 4,361,672. Examples of suitable methods for forming PSA's include, *inter alia*:

(i) compounding on a hot two-roll mill; (ii) melting the block copolymer and the tackifying resin and mixing the melted components until homogeneous; (iii) other methods employed in the plastic and elastomer industries, such as high shear intensive mixing, twin screw extrusion or tandem extrusion techniques; and (iv) dissolving the mixtures in suitable organic solvents such as toluene and heptane, taking care to form homogeneous solutions that are then coated on a substrate (e.g., on a film backing) before the solvent is evaporated.

Hot-melt compounding (any of methods i-iii, above) is not a favored embodiment of this invention. The heat from these methods can degrade the components of the PSA,

thereby creating more material that can potentially outgas from the PSA. However, the invention contemplates use of these methods provided that the resulting PSA outgasses less than 1500 ng/cm² as measured by Modified IDEMA M11-98 (described later).

Preferably, the PSA of this invention is formed by dissolving the mixtures in suitable organic solvents taking care to form homogeneous solutions that are then coated on the component for the computer device before the solvent is evaporated. Preferably, these solutions contain at least about 10, more preferably at least about 20, most preferably at least about 30, up to preferably about 80, more preferably up to about 60, most preferably up to about 50, weight percent solids based on the total weight of the solution.

Suitable organic solvents must be inert to the block copolymer and the tackifying resin. Additionally, the organic solvent must be selected such that substantially all of the solvent can be evaporated from the PSA. "Substantially all of the solvent" refers to removal of the solvent such that the residual levels of solvent are less than about 5% of the total outgassed materials per Modified IDEMA M11-98 (described later). Preferred organic solvents include toluene, cyclohexane and heptane, more preferably toluene.

The solvent can be evaporated from the PSA by any technique known in the art, such as vacuum drying or, preferably, exposure to hot air in a drying oven. The temperature of the hot air must be maintained below the autoignition point of the solvent. The appropriate drying conditions are dependent on the substrate to which the PSA is applied and the process time available for drying. For example, when using a substrate comprising a Type S polyester film (available from Du Pont), the preferred hot air temperature for evaporating toluene from the PSA of this invention is about 250 °F to

about 350 °F for a drying time of 2 to 3 minutes, more preferably about 325 °F to about 350 °F for a drying time of 3 minutes. The practical upper limit on drying time is determined from the available equipment and the desired production rate.

A hallmark of the PSA of this invention is that the PSA outgasses less than 1500, preferably less than 700, more preferably less than 50, ng/cm² as measured by Modified IDEMA M11-98 (described later).

Another hallmark of the PSA of this invention is that the PSA contains less than about 200 ng/cm² of bromide, chloride, fluoride, nitrate, nitrite, phosphate and sulfate anions combined, and less than about 200 ng/cm² of ammonium, as measured by Modified EPA Method 300.0 Revision 2.1 (described later).

The following specific examples will more precisely describe the invention and teach the procedures presently preferred in practicing the same, as well as the improvements and advantages realized thereby. These examples are provided for illustration purposes only and shall not be construed to limit the scope of the subject matter of the invention.

EXAMPLES

Example 1 - Measurement of Outgassed Materials

Outgassed materials are measured using the IDEMA M11-98 Dynamic (5/28/99DRAFT) Headspace Outgas Procedure (incorporated by reference) with the following method details or exceptions (Modified IDEMA M11-98).

The permanent and expendable equipment (Section 2) consists of a: (a) Type 303 stainless steel cylindrical chamber with approximate internal dimensions: 1.25 inches deep by 2.25 inches in diameter; (b) Supelco¹ stainless steel thermal desorption tubes

packed with the following sorbent: bed A= 100 milligrams Tenax TA, bed B= 250 milligrams Carbotrap B; (c) Hewlett-Packard² 6890 Gas Chromatograph/ 5973 Mass Spectrometer; (d) Perkin Elmer³ ATD-400 Automated Thermal Desorption Unit; (e) Reztek⁴ XTI⁵-5 gas chromatograph column, Reztek pn# 12223; and, n-hexadecane (Fisher Scientific⁶ pn# 03035) in dichloromethane employed as external standard for semi-quantitation.

The sample collection and analysis (Section 3) is conducted as follows. The thermal desorption tubes are conditioned at 320 °C for 8 minutes. Desorption tubes are installed and the samples are placed in the sample outgassing chambers. The sample chamber flow rate is set at approximately 50 milliliters per minute (ml/min.) using 99.99% nitrogen gas. The outgassing chamber is continuously heated at 85 °C. The desorber is programmed to desorb at 320 °C for 8 minutes at 50 ml/min. The cold trap is set at -30 °C and desorbed at 350 °C, with a hold time of 8 minutes, and valve and line temperatures set at 200°C. The outlet split is set at 54 ml/min. The sample split ratio is approximately 49:1. The gas chromatograph flow rate is approximately 1 ml/min.

Semi-quantitation is accomplished by injecting 5 microliters of a 200 nanogram per microliter dichloromethane solution of n-hexadecane into a heated sample chamber via an in-line injection port and outgassing onto reconditioned thermal desorption tubes for 185 minutes at 85 °C. The response factor is calculated by averaging the peak area of the total ion chromatogram for at least 6 replicates.

The amount of target compound or compounds is calculated (Section 4) by dividing the total ion count for the peak of the target compound or compounds by the external standard response factor and multiplying by 1,000 nanograms. The total

outgassing for the sample is determined by integrating the top 20 ± 2 peaks. The final result is expressed as nanograms per square centimeter where the sample area is determined by summing the area of both sides of a film sample.

Notes

- 5 (1) Supelco, Supelco Park, Bellefonte, PA 16823-0048 USA.
(2) Hewlett-Packard Company, Chemical Analysis Group, 2850 Centerville Road, Wilmington, DE 19808-1610 USA.
(3) The Perkin-Elmer Corporation, 761 Main Avenue, Norwalk, CT 06859-0010 USA.
10 (4) Reztek Corporation, 110 Benner Circle, Bellfonte, PA 16823 USA.
(5) XTI is a registered trademark of Reztek Corporation.
(6) Fisher Scientific, 711 Forbes Avenue, Pittsburgh, PA 15219-4785 USA

Example 2 - Measurement of Ions

Ion analysis is performed on an extracted sample by ion chromatography following EPA Method 300.0 revision 2.1 (August 1993)(incorporated by reference) as modified in Table 1 (Modified EPA method 300.0 revision 2.1). In this method, a small volume (typically 2 to 3 ml) of a sample is introduced into an ion chromatograph. The ions of interest are separated and measured, using a system comprised of a guard column, analytical column, suppressor device, and conductivity detector.

20 The specific details of the method are as follows. The ion chromatograph system consists of a Dionex DX500 Ion Chromatograph equipped with ED40 electrochemical detector, GP40 gradient pump, and AS40 auto sampler, all equipment available from Dionex Corporation. The sample extraction is prepared by cutting 100 cm² surface area of the sample (one side) by using a 4.4 cm x 22.6 cm template. The liner is removed from
25 the sample and positioned in a clean 200 ml pyrex beaker with the adhesive side inward so no part of the strip has the adhesive face to face. 100 ml of 18.3 MΩ-cm deionized water is added to the beaker which is then covered with 80 x 40 (No. 3140) pyrex top. The

beaker is placed in a water bath and heated to $80^{\circ}\text{C} \pm 5^{\circ}\text{C}$. The temperature of the sample is held at 80°C for one hour. After one hour, the beaker is removed from the water bath and allowed to cool to room temperature. The water with extracted ions is now ready for analysis.

TABLE 1

Modifications to EPA Method 300.0 Revision 2.1

<u>Method section</u>	<u>Cation Analysis</u>	<u>Anion Analysis</u>
6.2.1-6.2.2.2	Columns: Dionex CG12A 4 mm Dionex CS12A 4 mm	Columns: Dionex ATC-1 Dionex AG11 4 mm Dionex AS11 4 mm
6.2.3	Suppressor: Dionex CSRS II 4 mm	Suppressor: Dionex ASRS Ultra 4 mm
6.2.4	ED40 Electrochemical Detector DS3 Conductivity Cell Detection Stabilizer	ED40 Electrochemical Detector DS3 Conductivity Cell Detection Stabilizer
6.3	Software: Peaknet 4.3	Software: Peaknet 4.3
GP40/ED40 Timed Events Settings:	Isocratic analysis	Gradient analysis: <u>Initial to 9.50 min.</u> 90% A and 10% B <u>9.50 min. inject sample</u> 13.00 min 100% B <u>25.00 min.</u> 65% B and 35% C
Sample loop volume:	100 µl	100 µl
SRS current:	300 mA	300 mA
Pump rate:	1 ml/min	2 ml/min
4 point calibration Quadratic curve Correlation Coefficient.	>0.9999 for all ions	>0.9999 for all ions
Run time:	11 minutes	25 minutes
7.3	Eluent: 30 mN H ₂ SO ₄	Eluents: A: Deionized water (18.3 Mega ohm-cm) B: 5mM NaOH C: 100 mM NaOH

Example 3-Formulations

Below are examples of tape components which comprise the PSAs of this invention. Examples A - D are prepared with hydrogenated triblock S-EB-S copolymers, hydrogenated S-EP-S-EP block copolymers, hydrocarbon resins and an optional resin modifier for adhesion. The formulas of Examples A - D are shown in Table 2.

TABLE 2

Example PSA Formulas

Component	Function	A	B	C	D
		(parts)	(parts)	(parts)	(parts)
KRATON® G 1650 ¹	block polymer	2.91	2.41	4.69	7.87
KRATON® G 1657 ¹	block polymer	4.20	6.73	3.04	3.15
KRATON® G 1730 ¹	block polymer	38.91	40.15	39.83	39.45
REGALREZ® 1085 ²	tackifying resin	39.22	42.11	42.73	41.82
REGALREZ® 1018 ²	tackifying resin	7.75	5.91	4.74	4.65
MOR-ESTER® 49007 ³	adhesion modifier	7.01	2.70	4.97	3.07

¹ KRATON® is a trademark of Shell Chemical Company for block copolymers: G-1650 is a S-EB-S containing 30% styrene and 0% Diblock; G-1657 is a S-EB-S containing 13% styrene and 29% Diblock; G-1730 is a S-EP-S-EP containing 22% styrene and 0% Diblock.

² REGALREZ® is a trademark of Hercules Incorporated for hydrocarbon resins.

³ MOR-ESTER® is a trademark of Morton International Inc. for a semi-rigid, tacky polyester resin designed as an adhesive resin.

Adhesive solutions of samples A - D are prepared by dissolving the components in toluene to achieve a concentration of about 40% solids. A reverse roll coating device is used to coat the solution to a thickness of 0.0025" on each side of 0.0005" thick Type S polyester film available from DuPont. Each coated side of the film is dried by passing through a 12-ft, two-zone drying oven at 4 ft/min. The resulting dried adhesive layers are

0.001" in thickness. The air temperature in Zone 1 of the oven is 325°F, and the air temperature in Zone 2 of the oven is 350°F for the second coated side.

A Hewlett-Packard 6890 Gas Chromatograph/ 5973 Mass Spectrometer, used according to Modified IDEMA M11-98, is used to measure outgassing of Examples A -

5 D. The results of the outgassing measurements are shown in Table 3 along with typical ion levels for the formulas A - D. The total ion results shown in Table 3 are averages of several measurements and are reported as precisely as the accuracy and precision of the test method permits.

10 (A Dionex DX500 ion chromatograph equipped with an ED40 electrochemical detector, used according to EPA Method 300.0 Revision 2.1, is used to measure total ions for adhesive formulations.)

TABLE 3

Outgassing and Ion Data

	<u>Example</u>	<u>Outgassing (ng/cm²)</u>	<u>Total Ions (ng/cm²)</u>
15	A	30	<100
	B	16	<100
	C	28	<100
	D	21	<100

20 The results shown in Table 3 demonstrate that the PSA components of this invention (Examples A - D) outgas quantities of material well below a typical industry limit of 1500 ng/cm², and, in fact, can be made to outgas less than 50 ng/cm². PSA's made according to this invention also outgas substantially less material than does a comparative current polyacrylate PSA made under similar conditions.

The total ion contents reported in Table 3 demonstrate that the PSA's of this invention easily meet or exceed the industry standards of 800 ng/cm², and in fact, can be produced with total ion contents below about 100 ng/cm².

WHAT IS CLAIMED IS:

1. An improved method for preparing a computer device which includes at least one component bearing a PSA, the method comprising applying an improved PSA to the PSA bearing component, wherein the improved PSA comprises:
 - 5 A. at least one of a hydrogenated styrene-elastomer-styrene block copolymer or a hydrogenated styrene-elastomer-styrene-elastomer block copolymer, and
 - B. at least one tackifying resin.
2. The method of Claim 1 in which the PSA outgasses less than about 1500 ng/cm² as measured by Modified IDEMA M11-98.
3. The method of Claim 1 in which the PSA outgasses less than about 700 ng/cm² as measured by Modified IDEMA M11-98.
4. The method of Claim 1 in which the PSA outgasses less than about 50 ng/cm² as measured by Modified IDEMA M11-98.
5. The method of Claim 2 in which the PSA contains less than about 200 ng/cm² of bromide, chloride, fluoride, nitrate, nitrite, phosphate and sulfate anions combined and less than about 200 ng/cm² of ammonium, as measured by Modified EPA Method 300.0 Revision 2.1.
6. The method of Claim 1 in which the PSA contains less than about 100 ng/cm² of bromide, chloride, fluoride, nitrate, nitrite, phosphate and sulfate anions combined and less than about 100 ng/cm² of ammonium, as measured by Modified EPA Method 300.0 Revision 2.1.



7. The method of Claim 1 in which the PSA contains less than about 50 ng/cm² of bromide, chloride, fluoride, nitrate, nitrite, phosphate and sulfate anions combined and less than about 50 ng/cm² of ammonium, as measured by Modified EPA Method 300.0 Revision 2.1.
- 5 8. The method of Claim 1 in which the elastomer component of the hydrogenated styrene-elastomer-styrene block copolymer or the hydrogenated styrene-elastomer-styrene-elastomer block copolymer has the structure of at least one of poly(ethylene-propylene) and poly(ethylene-butylene).
- 10 9. The method of Claim 1 in which the elastomer component of the hydrogenated styrene-elastomer-styrene block copolymer or the hydrogenated styrene-elastomer-styrene-elastomer block copolymer is made by the polymerization of (i) isoprene, or (ii) 1,3-butadiene.
- 15 10. The method of Claim 1 in which the PSA comprises between about 5 to about 95 weight percent of the block copolymer and between about 5 and about 95 weight percent of the tackifying resin, both based on the weight of the PSA.
11. The method of Claim 1 in which the tackifying resin is a hydrocarbon resin.
12. The method of Claim 11 in which the tackifying resin is hydrogenated.
13. The method of Claim 1 in which the computer device is a data storage device.
- 20 14. A computer device comprising at least one component containing a PSA comprising:
- A. at least one of a hydrogenated styrene-elastomer-styrene block copolymer or a hydrogenated styrene-elastomer-styrene-elastomer block copolymer, and



B. at least one tackifying resin.

15. A computer data storage device comprising at least one component containing a PSA comprising:

A. at least one of a hydrogenated styrene-elastomer-styrene block copolymer
or a hydrogenated styrene-elastomer-styrene-elastomer block copolymer,
and

B. at least one tackifying resin.

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