

CHAPTER II

THEORETICAL AND LITERATURE REVIEW

2.1 GENERAL INFORMATION OF HARD DISK DRIVE FAILURE FUNCTION

2.1.1 Types of contaminants and its effect on the drive operation (7).

In rigid disk drives, the read/write head, or slider, is designed so that it flies over the disk when the linear velocity of the disk reaches a certain value; load-bearing film of air, or air-bearing film, is developed between the head and disk, as shown in Figure 2.1

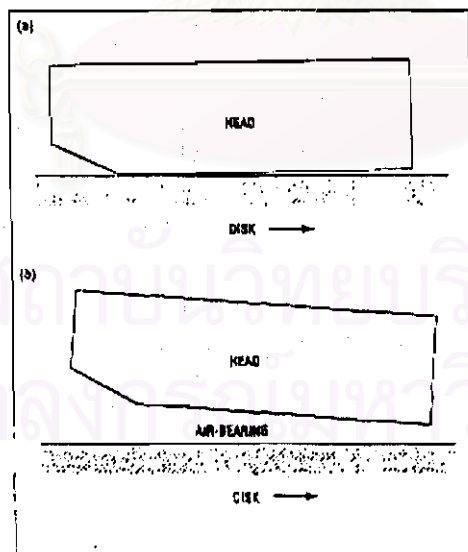


Figure 2.1 Schematics showing a disk-drive head (a) sliding and (b) flying on a rigid disk

Until this takeoff velocity is reached, the head slides on the disk, which creates friction and associated wear on the disks and heads, disks are coated with a thin layer (20 to 50 °A) of lubricant (7). The friction force (F) generates a torque ($F \times r$, where r is the radius at which the head is sliding on the disk). If the drive motor is unable to overcome this torque, then the drive is unable to spin to its operating speed and perform any data storage or retrieval. Typically, the friction force is high when a disk is spun up. Because the head breaks loose from its resting spot on the disk and begins to slide at this initial force, it is often called the *breakaway friction* or *stiction*. Stiction is normally associated with the forces developed as a result of menisci formation at the contact points between the head and disk (8 & 9). In a high-capacity/performance disk drive, as many as 20 heads can be attached to arms that are rigidly fixed to a rotating unit (see Figure 2.2). This whole assembly is called an actuator. The arms move radially among the disks, which are stacked on a motor driven spindle. In recent years, more and more heads and disks are being packed into smaller volumes to increase volumetric densities while the maximum motor torque available is being reduced. In addition, very smooth thin-film disks are being used by most drive manufacturers in order to fly lower ($\sim 0.1 \mu\text{m}$) and achieve high recording densities. Because of the large contact area and the small separation distance between the heads and disks, smooth disks tend to develop large stiction forces (8-12). The stiction force established at the head/disk interface also is strongly dependent on any condensation on the disk (9) and even microscopic wear on the heads and disks can strongly affect this force (7).

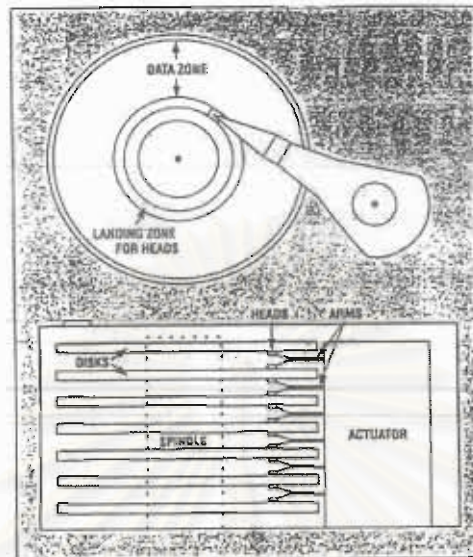


Figure 2.2 Overhead view (top) and cross section of a typical disk drive

2.1.2 Contamination concerns (1):

Organic vapors: Outgassing organic species are the most common drive contaminants and probably account for the majority of drive failures. As drives heat up in their “on” condition, organic residues on metal surfaces and in plastic and rubber components volatilize into the drive environment. These contaminants can then accumulate on the head and disk surfaces by condensation, entrapment, or frictional polymerization (1) such siloxane lead to the formation of silica particles (2). The accumulated material at the head/disk interface can alter the heads’ flying height (a particularly critical parameter with low-flying configurations) or induce wear in the disk lubricant and carbon overcoat. The contamination can also cause high start-up friction or even prevent

spin-up altogether (stiction). This problem is particularly prevalent with smaller spindle motors, which are unable to provide the needed breakaway torque.

The preponderance of adhesives, lubricants, rubber, and plastic components in HDAs provides many potential sources of organic contamination (1). Examples of emission from functional materials include hydrocarbons from bearing greases, silicone oils and residual monomers from silicone seals, caprolactam from Nylon parts, phthalate plasticizers from thermoplastic materials, hydrocarbons from hot melt adhesives, volatiles from uncured epoxies, and acrylics from pressure curing adhesives. Organic vapors can also evolve from residual contamination on component surfaces introduced during their manufacture, storage, shipping, and handling. Sources of process contamination include vinyl gloves rich in phthalate esters, cutting fluids from machining operations, contaminated cleaning solutions, dirt and vapors from manufacturing and testing fixtures, and plasticizers and monomers from bags and containers for storing parts. The rate of outgassing increases with temperature. Mass transfer of contaminant is much faster when the drive is running than when it is powered off, due to forced air circulation. The amount of contamination inside the drive increases with time, unless the design provides a means for its effective removal. Contamination also can be brought in from the external environment. This mechanism is particularly important if the drive enclosure has a high rate of air exchange with the ambient. Common types of atmospheric volatiles potentially affecting stiction include high-molecular-weight hydrocarbons, fatty acids and esters, phthalate and adipate plasticizers, alkyl phenols, methyl silicone oligomers, alkylene

glycols, and amines (13). While the levels of these species can be reduced by good quality control practices, their wide use makes complete elimination impossible. Also of concern are organics in the outside environment that may diffuse through a drive's breather holes or penetrate its seals. Disk drives in portable devices can be exposed to such external contaminants as fuel vapors, solvents and plasticizers.

Corrosive Agents: The thin magnetic layers on disk media are susceptible to corrosion because the thin lubricant layer and carbon overcoat on the disk do not provide adequate protection for the underlying cobalt alloy magnetics. Moreover, new magnetoresistive read/write head technology is even more sensitive to corrosion than thin-film and metal-in-gap configurations.

HDAs that are exposed to the external environment via breather holes or seal gaps are susceptible to typical airborne pollutants such as nitrogen dioxide, chlorine, and sulfur dioxide. As in the case of organics, corrosive agents can also be generated by components within the HDAs. For example, conversion coatings or other treated metal surfaces may have wet-chemical process residues such as sodium, potassium, chromates, nitrates, and other ionic species. Chlorine-bearing species are of particular concern, because of their high corrosion activity and their preponderance in process chemicals. Even chlorinated organics such as epichlorohydrin or chlorinated organics solvents pose a threat, since they can react or decompose to form chloride ions.

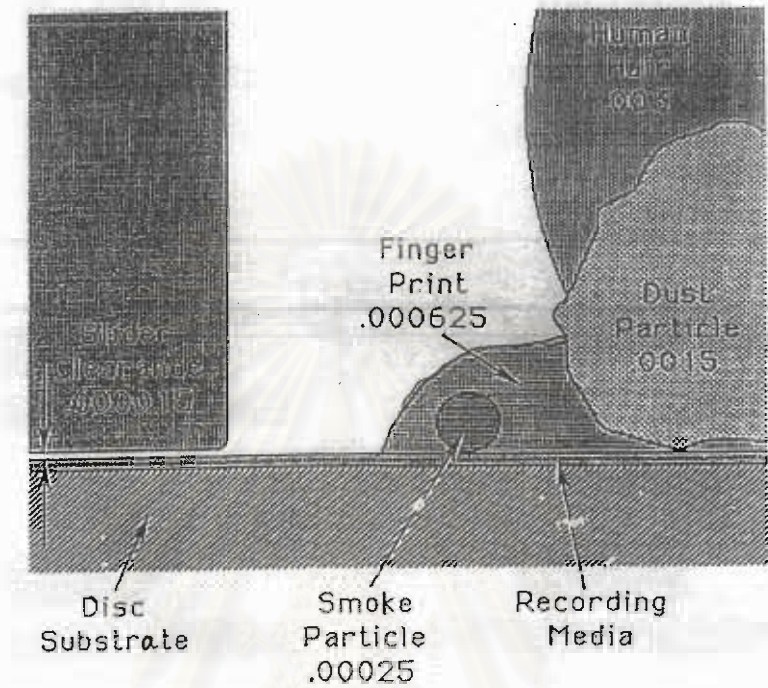
Water Vapor: Water vapor within an HDA is not considered a true contaminant; indeed, some minimum level of humidity appears to benefit drive performance. An overly dry environment increases the likelihood of static charge, and humidity may also play an important role in

lubricant at head/disk interface. However, the deleterious effects of high humidity are well known, the most important being its role in corrosion. Water vapor provides the mass transport mechanism for transferring corrosive ionic species from a component surface to the disk or head. It also participates in or catalyzes the corrosion reaction. In addition, high humidity has been linked with stiction problems.

While outgassing components in the HDA generates some water vapor, external humidity is a greater concern. The disk drives in portable computers are exposed to a broad range of environmental conditions and, at best, most sealed enclosures only slow the penetration of water vapor into the drive, rather than stopping it completely (1).

Thus, depending on the type and strength of various sources, the environment in commercial drives can range from very clean to highly contaminated (13).

Figure 2.3 Cleanliness Requirement: Contamination VS Flying Height (14)

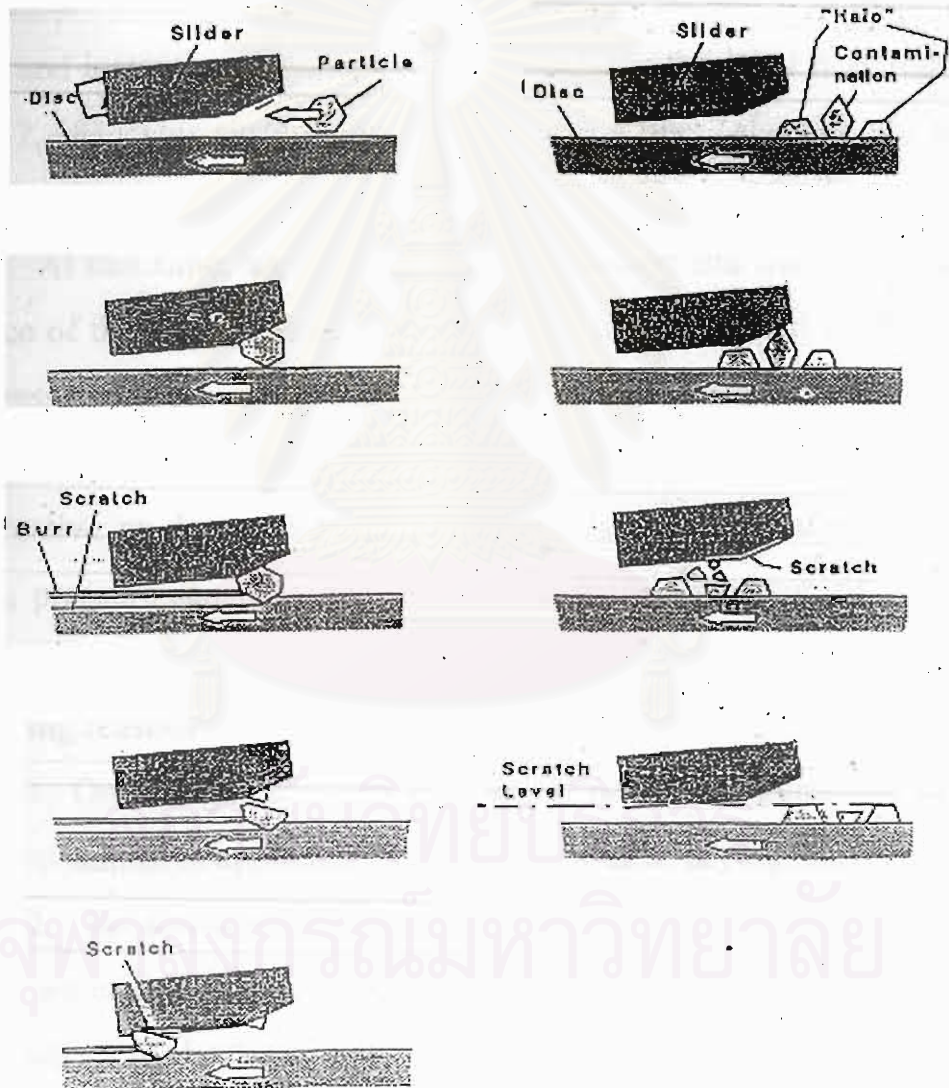


สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย

Figure 2.4 Head Disc Interface Failure (14)

Head/Media
Damage caused by Particles

Head/Media
Damage caused by
Media Contamination



2.2 Pressure-Sensitive Adhesive (PSA)

2.2.1 What is the composition of PSA and release liner?

2.2.1.1 Pressure-Sensitive Adhesive (15)

Pressure-Sensitive: An adhesive formulated so that it is permanently tacky and instantly adheres to whatever surface the label is designed for (16, 17, 18). This system normally requires a liner (also called a release sheet) which covers the adhesive until the label is ready to be fastened in place. At that time, the release sheet is removed and the tacky adhesive surface of the label is exposed. When the label is mated to the surface, the pressure-sensitive mass forms an instant bond with that surface.

In all instances, the fastening role of the adhesive is secondary to the informative or decorative purpose of the label. Over the past several years, pressure-sensitive adhesives have gained widespread preference over other label fastening adhesive systems primarily because of the following reasons:

1. Only slight pressure is needed; no messy gumming or other adhesive application equipment or after-drying step is required.
2. No activation step is needed, such as with pregummed labels where water activation is required. Nor is a heating step necessary to use, such as for heat seal adhesives, where care must be taken to assure adequate bond formation in the few seconds available prior to loss of adhesive tack properties, as the adhesive reverts back to a nontacky state.
3. Reliability of adhesive performance is ensured once the label or decal has been positioned.

4. The variety of pressure-sensitive adhesive types is at your fingertips: Permanent, removable by peeling, and even water washable. The user has a choice of selection not readily available with other methods of fastening. In most cases, and after various periods of elapsed time, the whole label can be removed (via the correct adhesive choice) without any noticeable deleterious effect to the previously adhered substrate.

a. Permanent: Conventional attempts at removal usually result in destruction of the label (19).

b. Removable: Removal is accomplished merely by careful peeling away from the surface (20).

c. Cold Temperature: For frozen food, the label is applied at subfreezing temperatures (21).

d. Specialty: Water-soluble pressure-sensitives, silicone rubber-based pressure-sensitives (22) and others are possible.

2.2.1.2 Adhesives Composition

Pressure-sensitive label adhesives as they will be dealt with here can some-what arbitrarily be further categorized as follows:

1) Rubber Based

Compounded adhesive with the elastomer system comprised singly or with any combination of natural rubber (or synthetic natural rubber), styrene-butadiene rubber, butyl rubber, nitrile rubber or a thermoplastic elastomer. To the elastomer backbone polymer(s) are added the

necessary tackifiers (resins), antioxidants (if called for, vulcanizing), the crosslinking agents with their required accelerators, etc. Fillers such as clays and whitening (calcium carbonate) are added whenever possible to reduce adhesive unit cost. Opacification of any adhesive is via addition of at least 5 phr rutile titanium dioxide. Zinc oxide may also be used for opacification but is not as cost-effective as titanium dioxide. The compounded rubber family was the original pressure-sensitive type available and remains a workhorse for most applications.

2) Single Component

Generally, these are acrylic-based copolymer or terpolymer systems(23) with the monomers chosen to confer specific desired performance properties with respect to tack, adhesion, creep resistance, heat stability, adhesive bleed, etc. This family is rapidly growing in areas requiring long service life (greater than five years). A specific adhesive may or may not be designed to crosslink additionally in service for added creep resistance (24).

3) Water Based

The adhesive is dispersed (latex form) in water and applied with appropriate means in the same fashion as in solvent coating and subsequent lamination.

2.2.1.3 Release Liners

The rapid acceptance of pressure-sensitive adhesives for mechanical (or machine applied) labeling over the past 20 years is directly attributable to the availability during this period of new release liners with evenly controlled release properties (25). Basically, automatic labellers all use practically the same technique (26, 27 and 28). A pressure-sensitive label in a roll is released from a protective backing by being pulled around a knife-edge (release liner against the knife-edge) so that label lifts away from the release paper. A vacuum head picks up the label on the printed side at a precise time, triggered by an electric eye or mechanical trip, cuts the vacuum and a positive air blast propels the label onto the piece to be labeled. Other machines pick up with a vacuum head and apply the label to the article being labeled directly with mechanical pressure. Others use one of these techniques plus a rolling, wrapping action to apply to circular subjects, etc.

As one case from the description of application method, the release characteristics of the liner are the key to successful uninterrupted machine performance.

Because a variety of adhesives exists in the market (i.e., removable vs permanent), no single liner will work satisfactorily with all adhesives. Both different adhesives and facings both affect release from a given liner. The end result is that to satisfy mechanical label application of various different label sizes, adhesives, etc., a whole host of release liners has evolved. Release liner construction is discussed in some detail since correct liner performance is the key to a successful pressure-sensitive labelling operation.

2.2.1.3.1 Release Liner Construction

1) Liner Backings

1.1) Paper

Usually a bleached or unbleached high internal strength kraft, super-calendered for exceptional smoothness is used. Basis weights start at about 49 g/m² and go up as high as 147 g/m². For optimum smoothness, the kraft extrusion is coated many times with 10-16 g/m² (6-10 lb/3000 ft²) polyethylene prior to release coating.

1.2) Film Liners

Usually biaxially-oriented polyester, polypropylene, or coextrusions of film combinations which exhibit good smoothness and uniform thickness. Most constructions used are in the thickness range of approximately 0.0025-0.0038 cm.

1.3) Others

Specialty sheet constructions can be release-coated, such as vulcanized fiber sheet, or extruded thermoplastic sheet, but these are not important for the mechanical high-speed labeling market.

2) Curing

This is the critical step in release liner manufacture. All silicone release coatings must be completely cured to form an insoluble three-dimensional polymeric network if they are to perform as intended without causing a pressure-sensitive adhesive and there occurs some mutual polymer interaction (intermingling or partial solvation into each other) with the disastrous result that the pressure-sensitive adhesive loses all of its quickstick or tack properties and cannot adhere to anything. Any reputable liner manufacturer has very rigid quality control standards to test for and guard against incomplete release coat cure.

3) Release Coatings (29)

Release coatings are important components of pressure-sensitive products. Tape, label, or sheet material with a pressure-sensitive adhesive must be protected from unwanted contact with other surfaces. Protection with a release sheet or, in the case of tapes, winding upon its own backing are the methods used to prevent the tacky mass from accidental sticking to other surfaces.

The low adhesion to the release-coated surface may be caused by several factors or a combination of them. The adhesive may poorly wet a release coating, so that a good contact is not established and the separation is easy. An agent, which splits cohesively at a low level of force, leaving a light deposit on the adhesive may impart release properties. A sufficient release may be obtained from a smooth and hard plastic surface without any release agent. In such cases, it is important to

prevent adhesive transfer from one to other side of the backing, because the release level might not be very low. Prime coating may be used to improve the anchorage of the adhesive to the other side and to assure that the separation takes place in the desired location. The surface over which the release coating is applied should be reasonably nonporous to prevent the flow of soft pressure-sensitive adhesive into the pores and irregularities, causing an increase in the unwind force. Backsize coating, which might not have the release characteristics, is often used on fabric or paper surfaces to provide a smooth and impermeable surface for the release.

In some cases, a rough surface may serve as a release plane. The adhesive contacts the surface only in a limited area because of its roughness. This allows for an easy separation.

A release coating is expected to meet the following requirements:

1. It should provide an adequate release. The release level should be sufficiently low to provide an easy unwind, but it should be high enough to prevent the flagging when the tape is wrapped over its own backing. Higher release level also minimizes the possibility of telescoping in the roll. The release agent should exhibit the “shingling” failure. The release should be allowed at a low peel angle and rapid at 90° Peel, normally used for the tape unwinds.
2. The level of the release should be easily reproducible. This requires that the release level is not very sensitive to the amount of release agent used.
3. The release agent should be firmly anchored and should not transfer to the adhesive surface causing a decrease in tack.

4. The aging properties should be good and the unwind should not change much on prolonged aging.

There might be other requirements for specific applications. Masking tape requires that the release coating has a good solvent resistance and that the paint adheres reasonably well to the release coating. Otherwise, the paint chips might fall off and remain adhered to the freshly painted surface. The release coating is applied over the backing from a dilute solution or dispersion. Light coatings of 2-3 g/m² or even fewer are sufficient. The anchorage of the release to the backing is not always sufficiently good and the release agents can be incorporated into the backsize coating. This improves the anchorage, and it dilutes the release agent. This method can be used to control the release level. In such cases, the coating weight is higher.

There are several groups of compounds, which are useful as release agents for pressure-sensitive tapes. Silicones, long chain alkyl branched polymers, chromium complexes, fluoro chemicals, and various hard polymers have been used for release purposes.

2.2.1.4 Silicones

Silicones are the most widely used materials for release coating applications. They give a low level of release and are useful for coating the release paper used in pressure-sensitive adhesive applications. While widely used for release sheets, silicone release coatings are not used that widely in tapes because of the extremely easy release. Generally, the force required to separate a pressure-sensitive adhesive from a silicone-treated surface by peeling is typically in the range of 4 to 15 g/cm. width.

That is too low for use as low adhesion back size in the tapes. Silicone release coatings (30) are available in solvent solution, aqueous emulsion or as 100% solids, usually added as monomers to be polymerized during the coating process.

Without silicone release coatings, the tag and label segments of the pressure-sensitive adhesives industry as we know it today would not exist. In the United States, silicone release coatings are used to produce products having an annual market value of over one billion dollars. Worldwide, products employing silicone release coatings have an annual market value of over two billion dollars (31).

These products include product identification labels, price tags, care and warning labels, name tags, display banners, bumper stickers, all kinds of packaging tapes, self-adhesive wall coverings, floor and carpet tiles, and transfer tapes used in manufacturing assembly operations, to name just a few.

Silicones were first produced commercially during World War II to protect electrical systems on aircrafts. Silicones are based on organosilicon chemistry where both the carbon-silicon bond and the silicon-oxygen bond contribute to their unique properties. Some of these properties are high temperature stability, good electrical insulating properties, weather resistance, and low intermolecular forces which result in low surface tension, low density, low heats of fusion, high compressibility (high molar volumes), low freeze point, and smaller changes in viscosity with temperature than other materials.

One of the properties of silicones is their chemical inertness, which results in low toxicity and inherent incompatibility with other materials. This incompatibility based on silicone's low polarity and low surface

energy led to several of the first nonmilitary “release” applications for silicones after World War II. Silicones were used to help keep automobile tires from sticking in their molds and fresh loaves of bread from sticking to their baking pans.

Silicone release coatings for the pressure-sensitive adhesive industry are extension of this early technology. The first silicone coating designed especially to provide stable, pressure-sensitive release was made commercially available in 1954 (32). Since then, new, improved products have kept pace with the industry’s increasingly sophisticated requirements. During these 25 years, silicones have remained the industry standard for achieving controlled pressure-sensitive adhesive release, primarily in the tag and label industry.

Figure 2.5 shows the basis construction of most pressure-sensitive laminates used for labels. The release liner, coated with a very thin film of thermoset silicone polymer, permits the laminated to be rolled up or stacked flat. For many applications, without the liner, the adhesive would stick to anything it touched and be impossible to store, ship or handle. Sufficient adhesion exists between the adhesive and the silicone coating to hold the laminate together during handling. But when it is time to use it, the label and its adhesive peel easily from the protective, silicone-coated release sheet.

The major component of a silicone release coating is polydimethyl siloxane. Thermosetting this polymer with a crosslinker and a catalyst produces an irreversibly crosslinked film that resists penetration by the organic adhesive with which it is laminated. Without crosslinking, the adhesive molecules would readily penetrate through the thin silicone film because of the flexibility of the siloxane polymer chain.

Silicone release coatings are commonly applied from solvent solution, but aqueous application is gaining ground along with 100% solids application. Release coatings are normally applied at coat weights from 0.16 to 0.81 g/m² (0.1 to 0.5 lb/3000 ft²). Because of the low coat weights, desired application methods from solvent or water are those best suited for controlled low add-on, such as gravure, or better yet offset gravure, wire-wound rod, and for water based. In most instances, some of post-coating application smoothing is employed prior to solvent or water drying).

1) Physical Properties of Silicones

One of several important physical properties contributing to the release characteristics of the polydimethylsiloxane polymer is its low surface energy, only 22 to 24 dyne/cm compared to a range of 30 to 50 dyne/cm for most organic adhesives (33). This differential helps prevent the silicone and adhesive from bonding tightly by preventing the adhesive from intimately wetting the silicone surface. The result is enough adhesion between silicone and adhesive to keep the adhesive in place, yet not enough to prevent easy parting of the silicone-adhesive interface.

Being nonpolar, silicone coatings exhibit low attractive forces for other molecules. Also, the polydimethylsiloxane is incompatible with organic polymers, including those on which most pressure-sensitive adhesives are based. However, the polydimethylsiloxane polymer is compatible with aliphatic and aromatic solvents. This made solvent-dilutable silicone coatings easy to apply from a coating bath. The

polymer requires little energy to activate viscous flow, making it relatively easy to apply in very thin films.

This means that the penetration of silicone polymers into porous substrates is not as much a function of temperature as it is a function of viscosity, i.e., molecular weight.

Pressure-sensitive adhesive release is a very complex phenomenon.

Table 2.1 lists the many factors that affect release characteristic

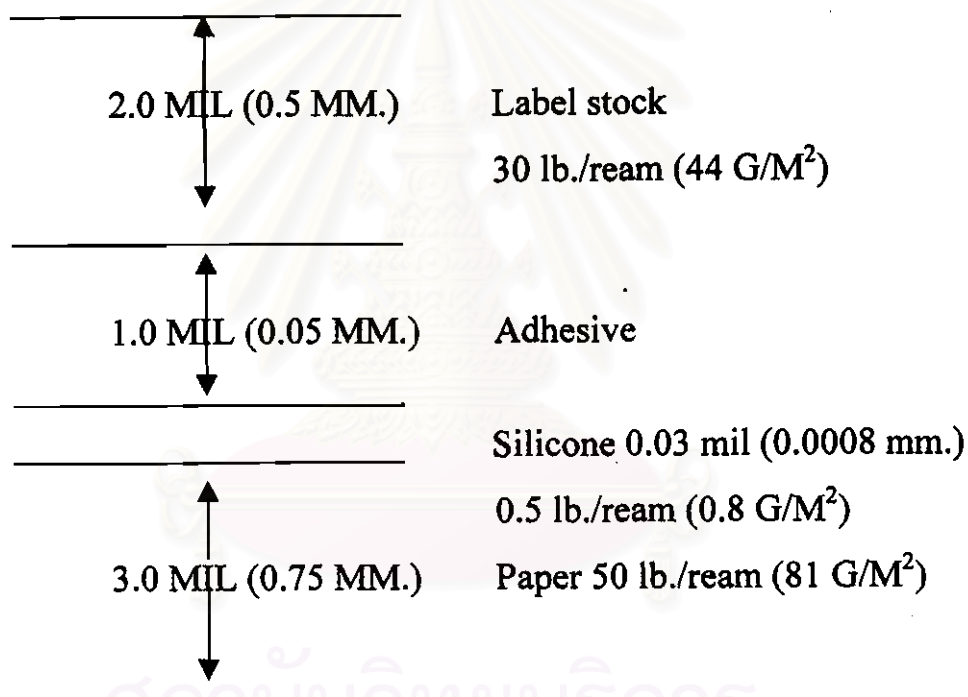


Figure 2.5 Schematic cross section of a pressure-sensitive lamination

Table 2.1 Factors Affecting Release Level

Nature of the adhesive	Laminate Characteristics	Nature of the silicone coating	Stripping Operation	Substrate Variations
Chemical type	Paper age	Chemical composition	Speed	Roughness
Thickness	Laminate age	Coating weight	Angle	Porosity
Modulus	Thickness and modulus	Film continuity	Physical dimensions	—
Diluents	Mode of adhesive application	Degree of cure	Crosslink density	—

One of the most important factors is crosslink density, the number of polymer crosslinks per unit volume in the cured film. Crosslink density is a function of the molecular weight of the polymer and the amount and structure of the crosslinker. This relationship provides the ability to vary the release characteristics of a silicone coating from very low or easy release to very high or tight release. Figure 2.6 illustrates how the molecular weight of the polymer determines crosslink density and release performance. All other parameters being equal, the higher the molecular weight, the higher the force required to release a given adhesive, and vice versa (34). Higher molecular weight polymers means longer polymer chains between crosslinks which means greater flexibility of the polymer chains. This greater flexibility allows more penetration of

the adhesive polymer chains into the silicone than a more highly crosslinked silicone coating.

The ability to vary the release characteristics of a silicone release coating makes it possible to provide different release values on opposite sides of the same substrate. Controlled differential release represents the most sophisticated application of silicone release technology. It is critical to the proper functioning of many complex labeling systems and transfer tapes used throughout industry.

Figure 2.6 Effect of crosslink density on release values

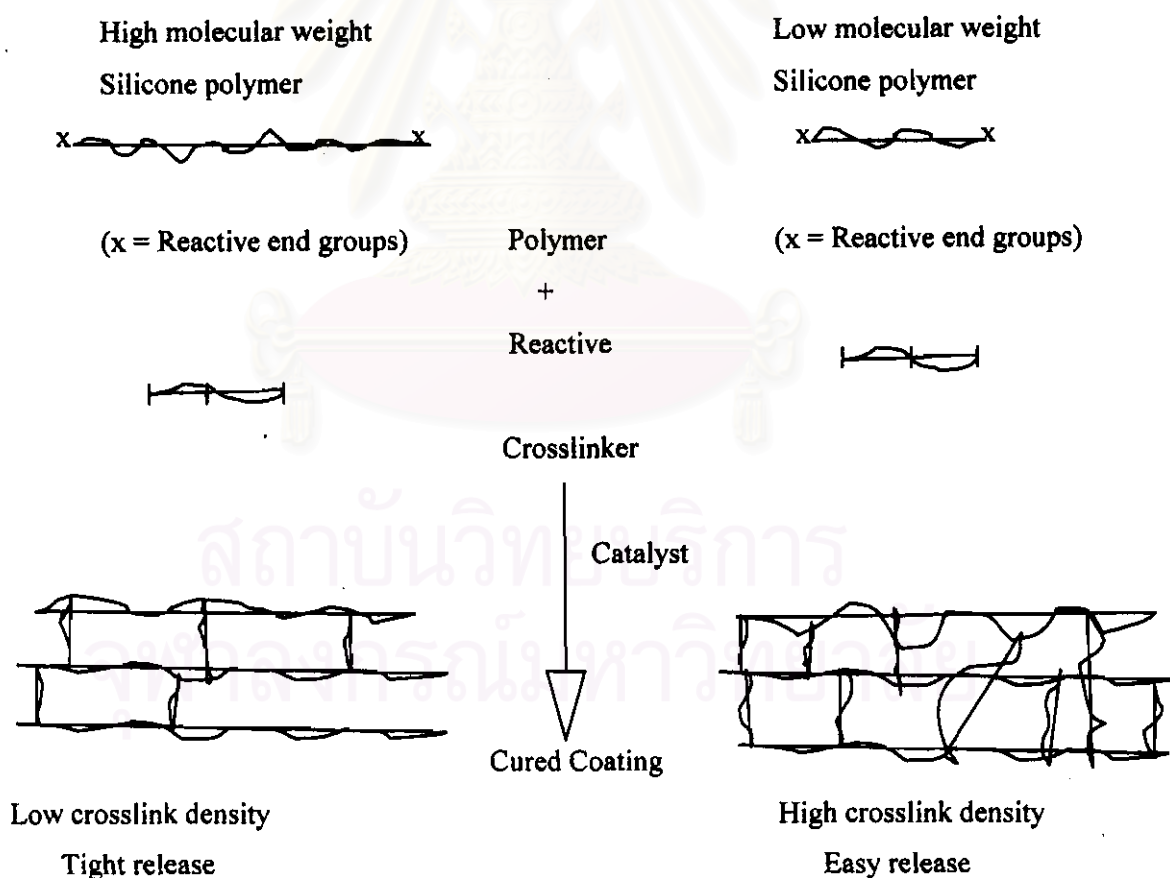


Table 2.2 Supporting Release Data

Silicone Coating	Release
Low crosslink density (e.g., Syl-off 23 paper coating)	125 G/IN (49 G/CM)
High crosslink density (e.g., Syl-off 291 paper coating)	50 G/IN (20 G/CM)

In a roll of coated substrate in the presence of heat, moisture, and pressure, the reaction can reverse direction.

2) Chemistry of Silicones

Thermoset silicone release coating systems consist of a reactive polymer, a crosslinker, and a catalyst. Mixing the components, applying the mixture to paper, and then heating to affect a cross-linking reaction will develop the coating. Two cure systems are available; one based on the condensation reaction and another on an addition reaction. The condensation reaction is the older one and has the most fully developed technology (30). The newer addition cure system offers several cure and release advantages (35-37). Moreover, the thermal cure systems, radiation-cured systems have been introduced. These systems are cured by ultraviolet (38) or electron-beam chemistry (39). The addition system was developed in Europe and Japan primarily for use with solvent-based coatings. Today, however, solventless (40, 41, 42) and emulsion (43) coatings can also be cured by the addition system. Although more expensive than the condensation system, addition cure offers several

release characteristics. There is no post cure; once the coating is properly cured, there is little tendency to block. Differential release can be achieved using different polymers and additives, and, as there is no post cure reaction, release equalization is not a serious problem.

At the present time, the addition system provides less processing flexibility than the condensation reaction. However, the technology is relatively new and increased processing latitude is not of the goals of continuing development work.

2.2.1.5 Methods of Application

1) Hot Melt

The adhesive is applied, as 100% solids generally by slot die extrusion, roll or gravure coaters. The adhesive mass may be applied directly to the facing, or may first be coated onto the release liner or a transfer liner prior to mating with the final facing material.

2) Calendered

While a common method of adhesive application in the past to cloth backings, this method is seldom used for label and decal production today.

3) Solvent Coating

The adhesive is dissolved in appropriate solvent(s) generally not exceeding 45% solids on a weight basis, and is then cast either directly

onto the facing, or first onto the release liner and then later the adhesive/liner combination is laminated to the desired facing.

2.3 Literature Review

Silicone compound was mostly used in pressure-sensitive adhesive release liner manufacturing detail in the literature survey as follows.

US Patent 4980440 (1990) "Fluorosilicone compounds and compositions for adhesive release liners" (44).

Craig K. K., Charles E. N., Jr.; Luretta A. S. Thomas J. T. and David L. S. revealed a unique organohydrogenpolysiloxane compound and to improve curable coating compositions comprising said compound. That were a new organohydrogenpolysiloxane compound and a new fluorosilicone polymer each have unique properties which allow for the preparation of faster curing coating compositions having longer bath life. This invention provide improved fluorosilicone coating compositions, provide a new organohydrogenpolysiloxane compound that is useful for more rapidly crosslinking a fluorosilicone polymer and provide a new fluorosilicone polymer which can be more rapidly cured with an organohydrogenpolysiloxane compound. This particular invention provide a curable coating composition which is useful for preparing a liner for silicone pressure-sensitive adhesives which has fast cure time and long bath life. The present invention which, briefly stated, relates to a new organohydrogenpolysiloxane compound, a new fluorosilicone polymer and to curable coating compositions comprising one or both of said polymers.

US Patent 5084317 (1992) "The pressure-sensitive adhesive release liner" (45).

Epple T. C. disclosed a release liner which had an improve mold conformability for use in a laminate including a formable layer comprising a carpet backing and a pressure-sensitive adhesive layer to be molded at an elevated temperature in a mold. This release liner including a film of thermoplastic material or blends of materials having a release surface including a cured silicone coating for releasable attachment to said adhesive layer with a release force value or range of values prior to molding. The rheological properties of the thermoplastic film at elevated temperatures are used to achieve mold conformability and retention of uniform release characteristics. A release liner comprising a thermoplastic film having a release surface including a cured silicone coating for use in moldable pressure-sensitive adhesive fastening tapes and laminates including a moldable or formable layer. The rheological properties of the thermoplastic film at elevated temperatures are used to achieve mold conformability and retention of uniform release characteristics. The silicone coating is applied to at least one surface of a film of the thermoplastic and cured at a temperature which avoids unnecessary softening of the thermoplastic film in order to provide a uniform and continuous silicone coating. Thereafter, the liner may be exposed to relatively higher temperatures in the molding process in reliance upon the rheological properties of the thermoplastic film to maintain the integrity and continuity of the cured silicone coating. Molding temperature exceeding the melting temperature of the thermoplastic and/or causing the melting of the film during molding have

not been found to significantly increase the release force and uniform release characteristics have been maintained.

Figure 2.7 Formation of a thermoplastic material having rheological properties



Figure 2.7 is a thermoplastic material having rheological properties suitable for the particular molding process. The thermoplastic material should have a deflection temperature such that the film becomes sufficiently supple due to softening or melting during molding to assure conformability. On the other hand, the melt index of the thermoplastic material should be sufficiently low to prevent degradation of the release surface due to excessive flow, thinning or disruption of the film.

Examples of suitable thermoplastic polymers or materials for use in forming the film include vinyl polymers, polyolefins, polystyrenes and ionomers. Preferred thermoplastics include polyvinylchloride, polyethylene, polypropylene, polypropylene copolymer, polystyrene and ethylene/methacrylic acid copolymer ionomers. The most preferred thermoplastics comprise ethylene/methacrylic acid copolymer ionomers having a melt index in the range of 0.5 to about 15.

US Patent 5248535 (1993) "Release sheet" (46).

Chang K. P., Fairport N. Y., Lu P. and Pittsford N. Y. revealed the composite film forming material suitable for use as release sheets. It more specifically refers to such composite materials having improved ink

adhesion characteristics. A composite sheet of a film form base liner, a cured release coating laminated to at least one side of the base liner, and a skin, on the top-most portion of the base liner and contains pendant acid groups. A composite, self supporting, flexible sheet comprising a film form liner having laminated to one side thereof a cured silicone-acrylate release coating wherein said release coating contains mobile portions. The improvement which comprises at least the side of said base liner proximate to said release coating. There is a skin thereon comprising a polymer containing pendant carboxylic acid groups in an amount sufficient to at least reduce the amount of said mobile portions from exiting said release coating and transfer to the other side of said base liner upon rolling up said sheet.

US Patent 5250336 (1993) "A colored release liner" (47).

Herve G. and St. Denis G. S. M. revealed a composition effective in improving the contrast between the release liner backing paper and facestock used in pressure-sensitive laminate manufacture through the addition of a colorant to the polysiloxane polymeric coating on the release liner. This invention provides a way for affecting coloration of the silicone release layer without changing the peel of a pressure-sensitive adhesive coated facing layer, nor the adhesive characteristics thereof. The ability to effect coloration to various and/or different colors in the silicone release layer of a pressure-sensitive laminate has many advantages. And is particularly useful when the coloration can occur within the silicone release liner itself without affecting the peel or the characteristics of the pressure-sensitive adhesive itself.

US Patent 5605730 (1997) "Label" (48).

Carl W. T. and Greensbora N. C. directed to a package label and method of forming a package label, and, more particularly to an adhesive backed label having an outsert carried thereon and a method for forming the same from a double coated adhesive tape or an adhesive transfer tape.

"Double coated tape", as used herein, includes a silicone release liner and a first layer of adhesive covered by a carrier which is in turn coated with a second adhesive layer. The first layer of adhesive is releasably mounted on the liner while the carrier is permanently coated on opposite sides by the first and second adhesive layers. Preferably, the carrier is a relatively thin polypropylene film. "Adhesive transfer tape", as used herein, includes a silicone release liner merely covered by an adhesive layer without a carrier or polypropylene layer. The adhesive is releasable from the liner

US Patent 5720499 (1998) "Adhesive label" (49).

Sakashita H. revealed an adhesive label which can be adhered to an adherend by placing a printed surface between a surface to be applied and the adherend. Said adhesive includes a label base formed of a translucent resin film, an adhesive layer provided on one surface of the label base, and a release liner attached to the adhesive layer. Slits are formed in the release liner to define an initial release liner portion and a final release liner portion. In the state in which the initial release liner portion is peeled off, the adhesive layer can be partially exposed, and printing is affected on the exposed surface of the adhesive layer. The present invention relates to an adhesive label, and more particularly to an adhesive label suitable for use when the printing of characters, codes, or

the like on an adhesive layer provided on a label base can be affected simply and in real time without requiring a plate making process.

The following patents are disclosed about the problem was related to hard disc drive failure.

US Patent 5742518 (1998) "Stiction model for a head-disc interface of a rigid disc drive" (50).

Gui, J. and Marchon B. disclosed a method of establishing an optimum stiction level on a given disc surface comprising establishing a glide height and available motor torque to a substantial approximation for a given disc drive. Thereafter establishing an optimum stiction level for the disc surface including defining a normal force on the slider. And defining a total meniscus force between the disc surface and the slider. Moreover, defining a quasi-equilibrium state for a disjoining pressure of the film on the surface of the disc relative to said meniscus force, describing a total volume of lubricant which is conserved during meniscus formation on the surface of the disc and thereafter calculation the stiction force for the disc surfaces.

The model has also been used to examine the effects of lubricants the disc overcoat the interactions between them. To ensure low stiction, a good approach is to maintain the applied to study the effects of the head variables on stiction. These effects may include form factor, crown, and the head pre-load.

The Effects of Airborne Organic Pollutants on Hard Disk Drive Performance

Smallen *et al.* (4) explored stiction on carbon-overcoat disks from contaminated. Dioctyl phthalate (DOP) was the major contaminant on the disk surface. The stiction force was decreasing disk roughness. The authors ascribed those results to surface tension and to viscous forces induced by thin films of liquid contamination at the interface.

Yamamoto *et al.* (2) studied the influence of DOP and siloxane outgassing on the contact region between rotating particulate disks and Al_2O_3 -TiC sliders. Both contaminants markedly increased the number of interface contacts, ultimately leading to head crashes. Interestingly, the damage occurred when the vapors first outgassed at 55 °C and then condensed onto the disk at lower temperatures. Similar temperature excursions often occur in the field, especially during storage and shipment of disk drives.

Yanagisawa (51) investigated friction between SiO_2 films, baked at high temperatures, and Al_2O_3 -TiC sliders. Upon exposing the film to air, he observed a large decrease in the film surface by high-molecular-weight hydrocarbons adsorbed from the air. Thus, depending on the circumstances, organics can be harmful or beneficial for the head-disk tribology.