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DuPont High Performance Films

DuPont High Performance Films

DuPont High-Performance Films: Tomorrow's Technology for Today's Engineering Design Needs.

From the space shuttle's solar array to miniaturized electronic components, from high-speed locomotive motors to microprocessor chip carriers, *Kapton*® polyimide films, only by DuPont, have made innovative design solutions possible. That's because *Kapton*® offers a unique combination of electrical, chemical and mechanical properties and retains these properties over a wide range of temperatures, where other engineering materials may fail.

Kapton® has more than 30 years of proven performance as the material of choice in applications involving very high or very low operating temperatures. Designers continue to discover that the application potential for this unique industrial material has barely been tapped. Additionally, the DuPont family of high-performance materials has been expanded to include *Cirlex*® adhesiveless manufactured all-polyimide construction material and *Oasis*® composite film, giving design engineers even more performance options to meet their needs.

Although we continuously explore new application possibilities for these films, many uses for *Kapton*® are well established. In the electrical and electronics industries, for example, *Kapton*® excels in applications for field coil insulation, substrates for flexible printed circuits, motor and generator armature slot liners, magnet wire insulation, transformer and capacitor insulation, magnetic recording and pressure-sensitive tapes and tubing, wire and cable insulation, speaker voice coils, automotive switches and bar code labels for printed circuit boards.

Versatile DuPont *Kapton*® and *Oasis*® Films

Kapton® HN is an all-purpose polyimide film that has been used successfully in applications at temperatures as low as -269°C (-452°F) and as high as 400°C (752°F).

Kapton® HN film can be laminated, diecut, slit, formed or adhesive-coated. It is available in 0.3 mil (7.5 µm), 0.5 mil (12.5 µm), 1 mil (25 µm), 2 mil (50 µm), 3 mil (75 µm) and 5 mil (125 µm) thickness.
Kapton® HA polyimide film has good flex life and is well-suited for general-purpose applications. It features an amorphous structure that is pliable, yet tough.

Kapton® HPP-ST offers the same excellent balance of physical, chemical and electrical properties over a wide temperature range as *Kapton*® HN film, plus superior dimensional stability and adhesion. It is available in 1 mil (25 µm), 2 mil (50 µm), 3 mil (75 µm), 5 mil (125 µm), 6 mil (150 µm) and 7 mil (175 µm)thickness. In applications where low shrinkage and/or superior adhesion are important, *Kapton*® HPP-ST is the polyimide film of choice.

Kapton® FN is *Kapton*® HN film coated or laminated on one or both sides with DuPont *Teflon*® FEP to impart heat sealability and to provide a moisture barrier and enhanced chemical resistance. It is available in a variety of constructions.

Kapton® BCL-Y eliminates the need for thick opaque coatings. It offers the thermal and electrical durability, as well as the chemical resistance of *Kapton*® HN, along with excellent surface reflectivity and bar code label contrast.

Kapton® KJ is a heat-sealable polyimide film used for high-temperature and high-performance material constructions. It maintains excellent adhesion well above its glass transition temperature.

Cirlex® adhesiveless manufactured all-polyimide laminate construction material complements DuPont *Kapton*® polyimide films. Available in sheets from 9 mil (225 µm) to 60 mil (1,500 µm), *Cirlex*® provides an expanded range of thickness options, while offering the excellent chemical, physical, thermal and electrical properties of *Kapton*®. It is readily modified by laser cutting, drilling, machining and chemical etching.

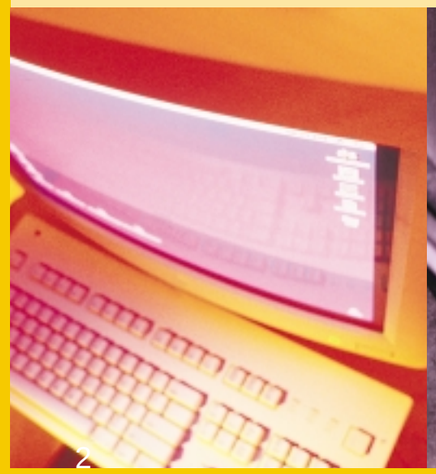
Oasis® composite film is heat sealable and is made using DuPont polyimide film and DuPont *Teflon*® fluoropolymer.

Oasis® composite film has excellent electrical, thermal, mechanical and chemical resistance properties.

DuPont *Kapton*® polyimide film can be laminated, coated and otherwise converted to meet a broad range of high-performance operating requirements. This outstanding versatility allows *Kapton*® to be custom-tailored to fit an almost endless variety of applications.

These high-quality performance films are supported by 30 years' experience, and we are committed to remaining the world leader in the manufacture and diversification of polyimide product offerings. Our significant investments in research, development and equipment in response to your needs continue to help us design products that can insulate or conduct electricity, as well as pigmented and heat conductive films, and new adhesive systems.

DuPont also offers custom-tailored products and programs to meet your special design requirements, where appropriate. For more information, please call 1-800-237-4357.





High-Performance DuPont *Kapton*® stands up to both low and high temperature extremes.

For all of its outstanding properties, *Kapton*® polyimide film, only by DuPont, is probably best known for its ability to withstand heat. With a UL®-94 V-O rating, *Kapton*® will not sustain or propagate flame. Nor will it produce any significant smoke when exposed to flame.

UL rated at 220°C to 240°C (428°F to 464°F) for continuous service, *Kapton*® can function for brief periods after exposure to temperatures up to 400°C (752°F). Best of all, it retains its high dielectric strength even at elevated temperatures — 2,500 V/mil at 300°C (572°F).

The outstanding thermal properties of these high-performance films provide significant advantages to the designer. When used on the windings of large coils for motors, insulation thickness can be significantly reduced; flexible circuits can be wave-soldered without distortion; and, when used in combination with inorganic insulating tapes, these films allow high-performance cables to continue to operate in direct exposure to flame.

***Kapton*® polyimide film is compatible with many high-temperature impregnating varnishes, including polyimides, esterimides, epoxies, silicones, amides-imides and organo-silicones, used to make today's electrical equipment. Magnet wire made with certain combinations of polyimide film and varnishes has a IEEE #57 thermal stability rating of 260°C (500°F).**

Flame and heat resistance aren't the only thermal advantages of *Kapton*® polyimide film. It also performs well at the other end of the temperature scale, retaining its properties and flexibility at -269°C (-452°F) without becoming brittle.

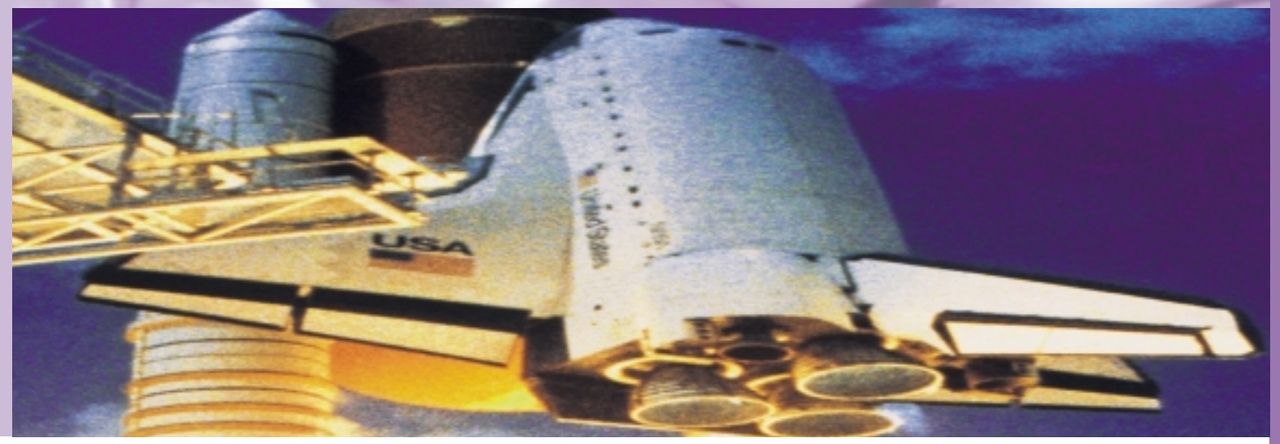
***apton*® MT and *Kapton*® MTB** films are available for applications where improved thermal conductivity is an important design feature.

***Kapton*® MT** provides thermal conductivity that is three times that of standard *Kapton*®. It has excellent physical properties and dielectric strength suitable for applications in heat-sink insulation for power transistors and power supplies.

***Kapton*® MTB** is a black polyimide film with increased thermal conductivity over *Kapton*® HN. The film's thermal radiation properties make it ideal for applications requiring efficient thermal energy transfer, such as loudspeaker voice coils and electrical insulating pads.

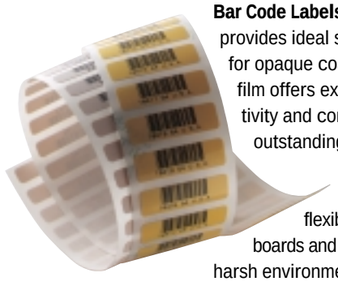
For speaker coils, *Kapton*® Type MTB , a black polyimide film, dissipates high levels of heat and provides outstanding electrical and thermal insulation. It has three times the thermal conductivity of standard *Kapton*® and resists distortion at high operating temperatures.

Lightweight and resistant to radiation, *Kapton*® HN film is the ideal insulation material for use in space applications. In spacecraft blankets, *Kapton*® 30/50 HN provides outstanding resistance to extremely high and low temperatures while maintaining superior dielectric strength, durability and flexibility.



Sink Pads. When used in heat …pads, *Kapton*® MT film provides …oved heat transfer compared …*apton*® HN, while maintain… dielectric strength for …face and cut-… protection.

Speaker Coils. *Kapton*® HPP-FST and HPP-ST films provide outstanding electrical and thermal insulation for speaker coils. *Kapton*® resists distortion at high operating temperatures, offers superior dimensional stability and maintains excellent adhesion with other materials used in speaker manufacture.



Bar Code Labels. *Kapton*® BCL-ST film provides ideal surface characteristics for opaque coatings. *Kapton*® BCL-Y film offers excellent surface reflectivity and contrast. Both films have outstanding temperature and chemical resistance for bar code labels for flexible printed circuit boards and other high-temperature, harsh environment applications.

Fiber Optics Cable. Using *Kapton*® HN film, fiber optics cable can be made smaller and lighter, allowing a much higher count conductor. The thermal resistance and low flame propagation of *Kapton*® HN help cables stand up to the UL® 1666 burn test. *Kapton*® HN is also non-porous, making it ideal for indoor/outdoor cable applications.

DuPont *Kapton*® polyimide film opens up your design possibilities with its outstanding electrical properties.

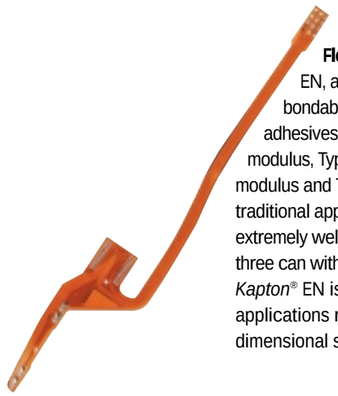
Next to its thermal properties, *Kapton*® polyimide film, only by DuPont, is selected by designers most frequently because of its excellent dielectric strength, dielectric constant and dissipation factor. The dielectric strength of 1 mil (25 µm) *Kapton*® — 7,000 volts at room temperature (23°C / 73.4°F) — is typically 2,500 volts even at an elevated temperature of 300°C (572°F). In fact, short-term exposure to temperatures as high as 400°C (752°F) will not significantly affect the electrical properties of *Kapton*®.

The combination of high dielectric strength, thermal stability, uniform thickness and excellent mechanical properties allows designers of electrical equipment to specify thinner insulation on coils for transformer, generator or motor windings. More conductors can be physically located within a given space, yielding greater power per unit. If the power requirement is constant, the weight and dimensions of a given coil, stator or rotor can be substantially reduced.

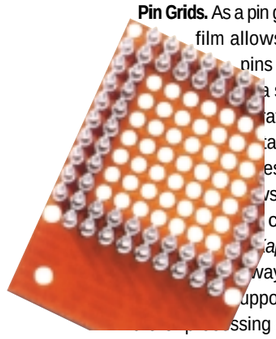
In flexible circuits, the high dielectric constant and low dissipation factor of *Kapton*® combine to reduce signal loss to a minimum at relatively low operating voltages.

***Kapton*® CR** polyimide film was developed specifically to withstand the damaging effects of "corona," which can cause ionization and eventual breakdown of an insulation material or system when the voltage stress reaches a critical level. *Kapton*® CR shows corona resistance of greater than 100,000 hr at 500 V/mil (20 kV/mm) at 50 Hz, and provides twice the thermal conductivity of standard *Kapton*®. These substantial property improvements open the door to new electrical design possibilities.

***Kapton*® XC** film is an electrically conductive, black polyimide film. A wide range of resistivities are available.

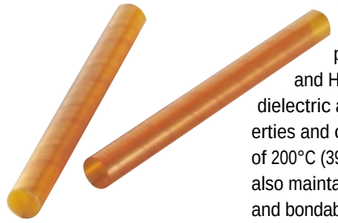


Flexible Circuits. *Kapton*® FPC, EN, and KN films offer excellent bondability to copper with various adhesives. Type EN has the highest modulus, Type KN has a mid-range modulus and Type FPC is well-suited for traditional applications. Adhesives work extremely well with these films and all three can withstand solder temperatures. *Kapton*® EN is well-suited for use in applications requiring exceptional dimensional stability.



Pin Grids. As a pin grid array, *Kapton*® HN film allows insertion of all pins into a circuit board a single, high-speed ation. *Kapton*® HN ands the high tem- es of wave soldering s visual inspection of connections. After apton*®* HN can either way or left in place as upport for pins during ssing and handling.

Pressure-Sensitive Tape. Whether it's used as protection for printed circuits during the manufacturing process, or as a repair/utility tape for high-performance electrical insulation applications, *Kapton*® PST film provides high-temperature capability, dimensional stability, resistance to solvents and compatibility with many types of adhesives.



Insulation Tubing. In tubing used for electrical insulation protection, *Kapton*® HN, MT and HPP-ST films have excellent dielectric and thermal insulation properties and can withstand temperatures of 200°C (392˚F) or higher. These films also maintain good physical properties and bondability for manufacture of this spiral wound, high-temperature tubing.

DuPont *Kapton*® polyimide film resists most chemicals, solvents, lubricants and fuels.

***Kapton*® polyimide film, only by DuPont, is an ideal material for use in demanding environments where hostile elements such as chemicals, gases and radiation are present. Whether it's used as motor windings insulation in an oil well pump operating in a pit of gas and brine 20,000 feet (6,095 m) below the surface of the earth, a protective layer for a liquid level sensor submerged in an organic solvent or in demanding automotive applications, *Kapton*® can take the punishment and still deliver reliable performance.**

In flexible circuitry, conductors bonded between layers of *Kapton*® polyimide film are protected against chemicals, moisture, gases and foreign materials so they can operate reliably in demanding environments. In military and industrial applications, *Kapton*® remains tough and flexible. Although it is unaffected by most organic chemicals, solvents, fuels and lubricants, *Kapton*® can be dissolved by certain strong bases — a fact that printed circuit manufacturers use to their advantage in the chemical milling of features in printed circuits.

***Kapton*® FN** is a heat-sealable film that retains the unique balance of properties of *Kapton*® HN over a wide temperature range. This is achieved by combining *Kapton*® HN with DuPont *Teflon*® FEP fluoropolymer in a composite structure. *Kapton*® FN imparts heat sealability, provides a moisture barrier and enhances chemical resistance.

***Kapton*® WR** polyimide film was developed specifically to combat the effect of water on insulation systems and for applications where hydrolytic stability is important. It is available as plain film or laminated with DuPont *Teflon*® FEP (*Kapton*® FWR) for use as a heat-sealable magnet wire insulation.

Automotive Diaphragms. Although thin and lightweight, *Kapton*® HN and FN films can withstand flexing without developing cracks or tears, which are typical problems encountered with rubber and other common materials. *Kapton*® enables diaphragms and other parts to work "in movement" under high pressure and remain flexible and functional, while performing for a half-million plus cycles.

Automotive Sensors. *Kapton*® HN and FN films are used in automotive sensor devices because they are flexible, highly processable and able to withstand the extreme temperature changes that occur under the hood. These films also have excellent durability and proven resistance to automotive solvents, oils and fuels.

Etched Applications. *Kapton*® is etchable and can be well controlled within the etching process, resulting in a fine line capability and high quality of etching. Although *Kapton*® HN or HPP-FST films are most frequently used for chemical etching, several other types of *Kapton*® have also been successfully etched.

Etching Controllability. *Kapton*® HKJ film is made from layers of *Kapton*® HA and KJ film, which have been bonded together. In this application, the *Kapton*® HA film has been etched through, while leaving the *Kapton*® KJ polyimide adhesive intact.

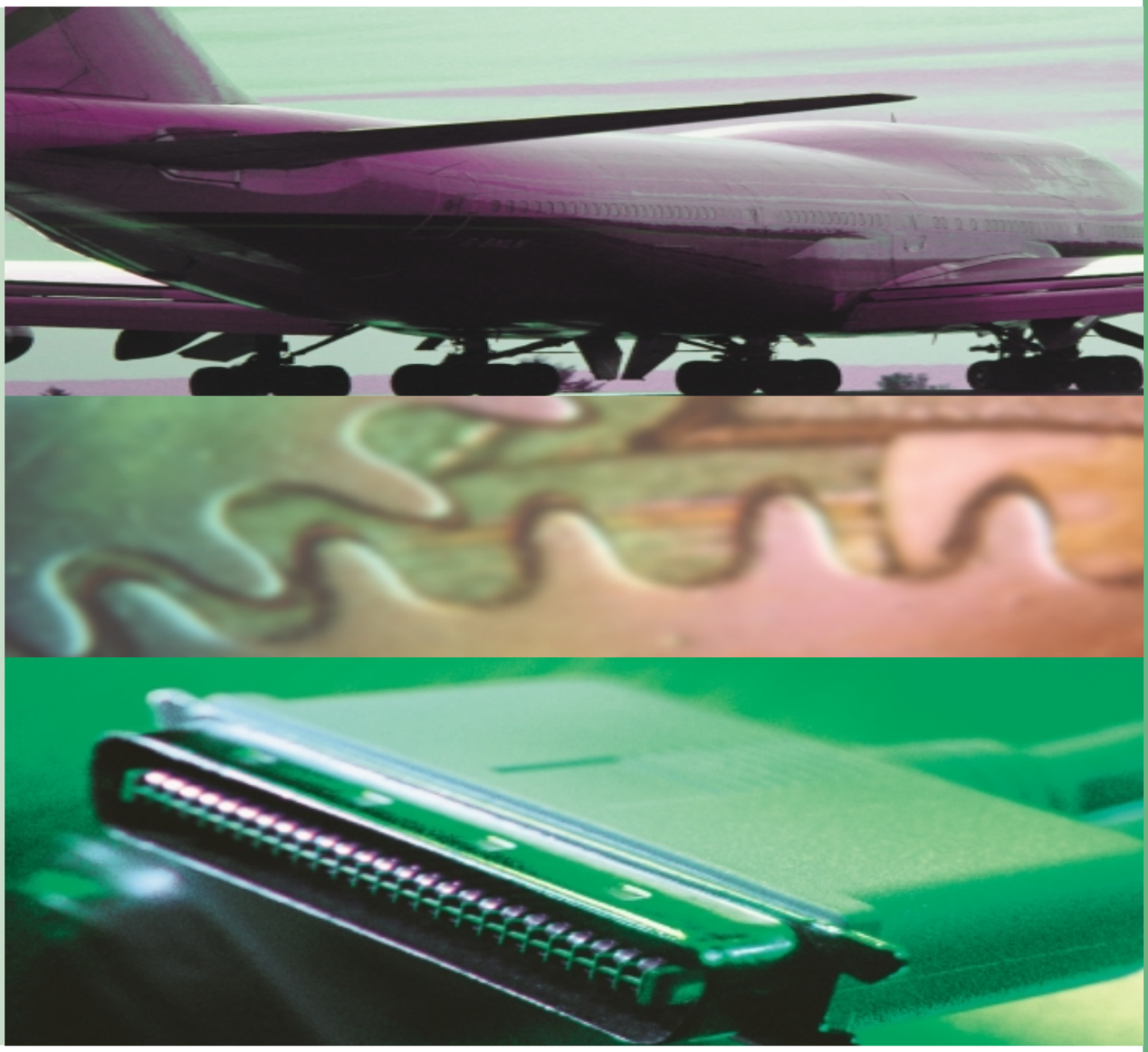
DuPont *Kapton*® polyimide films and *Oasis*® composite films are proven strong, tough and abrasion resistant.

***Kapton*® polyimide films and *Oasis*® composite films, only by DuPont, provide a host of performance options not available from conventional materials such as fibers, resins, metals, glass, ceramics, mica and others. The films' tensile strength and initial tear resistance provide the mechanical durability necessary for many critical manufacturing operations, such as printed circuit processing and installation. Exceptional toughness and resistance to cut-through and abrasion make *Kapton*® and *Oasis*® especially useful as insulation for aerospace and communications wire and cable, where it can be pulled through even the tightest routing.**

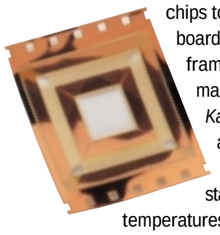
Since the outside diameter of a wire or cable insulated with *Kapton*® polyimide film or *Oasis*® composite film is smaller than conventional wiring using extruded insulations, more cable can be run through a given size conduit or plenum. Stripping and termination are also easier.

The strength, toughness, flexibility and wear resistance of *Kapton*® polyimide film have proven reliable for a number of non-electrical applications as well, such as drive belts, pressure switch diaphragms, wear strips, washers and seals. Three-dimensional shapes of *Kapton*® are also available.

***Kapton*® JP** polyimide film provides optimum forming characteristics. It offers higher elongation at elevated temperatures, while maintaining the combination of excellent physical, electrical and mechanical properties inherent in *Kapton*® HN and HA. The polymer properties of *Kapton*® JP enable drawing deeper parts at lower temperatures in shorter cycle times. After forming, parts exhibit excellent shape retention and minimum shrinkage.



Lead frame tape. Used to secure chips to circuit boards, lead frame tape made from *Kapton*® EN and KN films remains stable at high temperatures and provides the same thermal coefficient of expansion as copper.

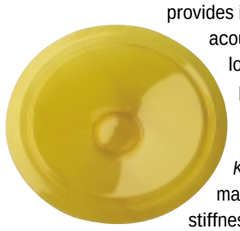


Automotive Manifolds. *Kapton*® HN and FN films are specified for use in automotive manifolds because they are able to withstand temperature extremes, mechanical stress and contact with organic solvents. These films are unmatched for their resistance to fuels, fluids and other harsh chemicals.

Shims of *Cirlex*®. *Cirlex*® is an adhesiveless all-polyimide laminate construction material that possesses the same thermal and physical properties as *Kapton*® polyimide films. A thicker alternative to *Kapton*®, *Cirlex*® helps eliminate weak points in adhesive construction and can be used as shims.

Aircraft Shims. *Kapton*® HN is lighter than metal, and more compatible with the advanced composite materials now used in aircraft assemblies. The multi-layer shims can be easily peeled to fill the gap.

Speaker Cones. *Kapton*® JP film provides improved acoustics and longer life for precision-formed loudspeaker cones. *Kapton*® JP film maintains a higher stiffness-to-weight ratio than conventional speaker part materials, displays superior electrical properties and withstands high wattages.



Solder Mask Frames. Used in solder stencils for printed circuit boards, *Kapton*® HPP-ST (shown) and *Cirlex*® maintain through-hole definition, dent resistance and longevity better than stainless steel. *Cirlex*® also offers a smoother surface for more efficient disbursement of solder paste.