TECHNICAL NOTE

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An Introduction to the Gel Pen

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ABSTRACT: A new "class" of writing ink, whose ink has new chemical features, is being introduced into the United States from Japan. The new ink is known as gel ink and it is water-based. It can be differentiated from the traditional water-based roller ball and porous tip class of writing inks by its chemical composition and physical properties. Gel inks differ from other water-based inks by the incorporation of colored pigments to give the inks a full range of colors without the use of colored dyestuffs commonly used in water-based inks. Other differences include gel ink's high viscosity, leading to the name "gel ink." The gel pen is visually identifiable and different in appearance from other writing instruments by its clear outside barrel and fill tube, which contains the pigmented gel ink. The pen housing and fill tube is clear in order to display the actual color of ink. The plastic fill tube will be a larger diameter than the tube found in a ballpen and will contain a clear silicon grease plug. Gel inks are tested and differentiated from other writing inks by the same battery of tests used in the past. Nondestructively, gel pen writing can be visually examined for ink absorption into the paper fibers, color difference and overall line quality of the writing. Ultraviolet and infrared light examinations will also aid in differentiating gel inks from other writing inks. Destructive methods of testing gel ink may prove to be the most identifiable and demonstrative of all the available tests. Thin layer chromatography may be used to separate detectable components of inks. Gel inks that contain pigments and no dyestuffs for separation, will have a negative reaction in this area. The gel pen is a unique writing instrument because of the chemistry in the gel coupled with a new pen design. The water-based gel ink is environmentally friendly and permanent. These attributes may allow the gel pen a sizeable impact on the U.S. market.

KEYWORDS: forensic science, questioned documents, gel ink, dyestuffs, pigments

The advent of the rollerball pen with water-based ink, around 1970, introduced the document examiner to a new class of writing instrument and ink. New ink categories and new examination techniques had to be formed to characterize these pens and document their characteristics.

Recently, another class of writing instrument has emerged from the Far East. This new writing instrument is known as a gel pen and its ink is a water-based, pigmented, gel ink. What differentiates the gel ink from traditional types of water-based ink is the incorporation of black and colored pigments, which give the pen a full range of colors without the dyestuffs commonly found in most other water-based inks. Ink chemists use special pigments, resins, and additives to give the gel ink its unique characteristics, such as the very high static viscosity needed to support the ink in the pen tube. The ink is formulated to become thinner when the pen is used, which allows the ink to flow through the tube and print properly for the duration of the pen's life.

Four brands of Japanese gel inks have been obtained and examined: the Uni-Ball Signo by Mitsubishi Pen, the Zebra J-5 gel pen, the Pentel Hybrid-2, and the Sakura Gelly Roll. Only the Gelly Roll and the Pentel Hybrid-2 have been found to be currently on the market in Southern California. The Zebra J-5 and Gelly Roll pens have ink which come in a variety of colors ranging from black, shades of blue, green, brown, and purple, to highly fluorescent colors of orange and yellow. The only Mitsubishi pen that could be obtained for testing contained red ink, although a selection of ink colors are available in Japan. The Pentel Hybrid-2 is being sold with both black and blue inks.

The pens tested from the four pen companies listed above all contained their own individual characteristics in regards to ink colors and writing performance.

Ink color ranged from a sharp, true black found in the Gelly Roll, to a distinctively lighter shade of black found in the Pentel and Zebra pens. The three blue inks, two Gelly Roll and one Pentel, all contained their own distinctive shade of blue.

The written line quality created by these pens varied, depending upon the quality of the ball, ball housing, and ink formulation (1). Gel inks, as a result of being pigmented and of high viscosity, do not tend to bleed into paper fibers nearly as much as a typical water-based rollerball or water-based, porous tip ink. The Gelly Roll pen had the heaviest ink flow onto the paper and closely resembled the writing characteristics of a rollerball pen. The Pentel, Zebra, and Mitsubishi pens had a more moderate ink flow and required slightly more pressure to create a consistent ink line.

The gel pen is visually distinguishable from other writing instruments on the U.S. market. All of the gel pens that have been tested use a clear or semi transparent outside barrel and a clear or semi-transparent fill tube. This is done to allow the user to see the color of the ink contained in the pen and also the amount of ink that is left in the barrel. At the end of the ink supply is a clear grease plug of approximately one-quarter inch in length. The plug prevents the ink from backleaking and helps the ink flow down the barrel

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without leaving residual color on the pen barrel. Most water-based rollerball pens and porous tip pens have opaque barrels and all have fill tubes containing nylon or acetate fibers, which are used to support the low viscosity ink in the barrel. This visible difference can easily be observed when comparing a gel pen to a rollerball pen or a porous tip pen.

The inks mentioned earlier were all subjected to ultraviolet and infrared light examination using a VSC-1. The Gelly Roll black and blue, Mitsubishi red, Pentel black and blue, and the Zebra black and blue inks all reacted negatively to both light sources, giving off no fluorescence for these colors (2). Both the Zebra and Gelly Roll pens were available in ink colors designed to have fluorescent qualities ranging from a bright yellow to a glowing orange, depending upon the color used.

Thin-layer chromatography (TLC) proved to be a primary technique for the identification of pigmented gel inks. Ball pens, most rollerball pens, and all porous tip pens contain dyestuffs to give the ink its necessary color. These dyestuffs will be detectable on a TLC plate and can be used to identify the ink (3). Gel inks, which normally lack any dye components, will not display any movement on the TLC plate, making them quite distinguishable.

To quickly determine if the ink in a writing sample is a gel ink, place a drop of chlorine bleach onto the sample. If the sample reacts with an immediate color change or the line fades, it can be assumed the ink is not a gel ink.

Gel inks have other characteristics that can aid a chemist in differentiating gel inks from other water-based inks or ball pen inks. These unique characteristics are seen in the resin selection, pigment selection, pigment particle size, and color. The resin selection used for gel inks can be evaluated on a comparative basis using resin separation techniques coupled with an FTIR. Pigment selection and pigment particle size is very important in gel pens. Very specific organic pigments are used for formulating gel inks, and their particle sizes are very small, usually less than one-half micron on average. The colors of these pigments can also be used for differentiation of the pens.

One of the primary reasons for the gel pen is the world wide push to environmentally friendly writing instruments containing little or no volatile organic components or other hazardous materials. The pigments used in the gel pens will not be likely to contain any heavy metals, but rather will be organic and environmentally safe. The resins will be non-toxic, as should the additives in the ink formulations. The gel pen is an attractive instrument for future marketing in the United States for several reasons: The environmentally friendly formulations, the variety of vibrant colors which appeal to the younger generation, and the archival qualities necessary for certain documents.

Japanese companies have already been marketing the gel pen in their own country since the mid to late eighties. The pens have been in the U.S. in a limited supply for approximately 2 years, with the most notable being the Sakura Gelly Roll. A really wide distribution of gel pens has not yet been observed in Southern California. Only large stationary stores have been found to carry the pen, which cost about $1.00 each.

Two California ink companies are known to be producing gel inks at this time: Formulabs, Inc. of Escondido, and National Ink of San Diego. The gel inks produced by these two U.S. companies are being sold to various pen manufacturers. Formulabs and National Ink are not known to be tagging their gel inks at this time.

The United States seems destined for a sizeable distribution of gel pens in the near future. This volume, although small today, will undoubtedly increase to make the gel pen an important new class of writing instrument in the field of document examination.

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