GLITTER as Forensic Evidence

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I. Statement of the problem.

The purpose of this paper is to provide a *general review* of glitter as *associative* evidence. This *general review's* ultimate goal will be to assist forensic laboratories in their preparation of a *validated protocol* for both the collection of glitter trace evidence from suspects, victims, and evidence, and for the forensic individualization/comparison of glitter trace evidence.

II. What are the properties of the *ideal* contact trace?

Locard's Principle states that *every contact leaves a trace*. In criminal cases these exchanged traces may help to show as association between suspects/victims/and crime scenes. However, not all potential contact traces are of equal evidential value. Before we consider the specific properties of glitter, let's consider the hypothetical properties of the *ideal* contact trace. At the conclusion of this paper we will then cons ider how closely glitter approaches this ideal.

1. ***Nearly invisible.*** **If exchanged traces are readily visible, the suspect will likely be aware of them and either take measures to remove them or discard those items bearing obvious traces.**
2. ***High probability of transfer and retention.*** **The larger GSR particles typically either don't transfer or rapidly fall off. Tiny particles of just about anything readily transfer and cling because of static electricity.**
3. ***Highly individualistic.*** **Trace evidence is *class* rather than *individual* type evidence. The smaller the class or subclass into which a particular type of trace evidence may be assigned, the greater its evidential value. For example, although white cotton fibers may be nearly invisible and may have a high probability of transfer and retention, they are too common and (for now) have little potential for discrimination.**
4. ***Easily collected, separated, and concentrated.*** **Dandruff might have great value as associative evidence, but how do you collect it, separate it from other debris, and separate out and characterize only that dandruff originating from a particular suspect or victim?**
5. ***Mere traces easily characterized.*** **Without the development of the polymerized chain reaction (PCR), saliva stains would have had limited evidential value.**
6. ***Searchable via computerized database.*** **For associative evidence to have value, there must be means for an assessment of its rarity, even if this is only a general estimate. This assessment is greatly facilitated if the properties of the evidence type can be entered into a searchable database. For example, way**

back in the nineteen sixties Elmer Miller of the FBI Laboratory began a database for glass trace evidence. With each new case having glass as trace evidence he would not only measure its properties (density, refractive index, etc.) and make new entries, but he could also search the database to see how frequently glass with these properties had been encountered previously. One of the reasons that the microscopic comparison (no DNA) of human head and pubic hairs remains such a controversial area is that almost all the measurements are subjective and cannot be entered into a computer-searchable database. Therefore, although all agree that through microscopic comparison alone it is not possible to individualize human head or pubic hairs, any assessment of rarity must be done on an ad-hoc basis (natural redheads are rarer than those with black hair) and is highly subjective.

7. ***Will survive most environmental insults.*** **Human odors might be quite distinctive, but think how quickly they are lost from a room, or break down and change if emanating from a dead body. Until the advent of DNA profiling, one of the limitations of the various enzyme systems used for typing bloodstains (PGM, etc.) was their tendency to break down with time.**

III. What is glitter?

Glitter is entirely manmade. It starts out as large rolls of foil or plastic (may consist of several individual layers) and is the cut into tiny particles. To minimize waste the glitter pieces are cut into shapes that can entirely fill a two-dimensional surface, i.e.,

- hexagons, squares, or rectangles. On labels for cosmetic products, glitter may be confused with *shimmer.* Shimmer most often begins as tiny pieces of mica. Coatings of titanium dioxide can add color (which color depends on the thickness of the coating) and sparkle, and other coatings such as iron oxides or bismuth oxychloride may also be present. Like glitter, shimmer has potential as associative evidence. However, shimmer will not be considered in this paper.

Glitter may be found in just about every type of cosmetic product; it is extensively used in arts and crafts [often by children, and I hardly received a Christmas card (if I can use that term in a paper that will appear in a U.S. Government publication) that didn't use the decorative effect of glitter]; it is extensively used for decoration on garments, and is incorporated in clear plastic products.

Just as with other types of trace evidence, the more manufacturers there are the better our chances of being able to discriminate between glitter particles originating from different sources. Although the number of manufacturers keeps changing, there are at least a dozen worldwide, including Pakistan, China, Korea, 3 in the USA, 2 in Germany, 2 in India, and 2 in Taiwan. There are some companies that just make the film but do not cut it into glitter, and there are other companies that just buy the film from these manufacturers and then cut it into glitter.

IV. How to find and recover glitter from suspects, victims, and evidence.

Because the individual glitter particles act like tiny mirrors in reflecting light, individual glitter particles are easily located with a flashlight under subdued light. If you are specifically looking for glitter particles, this is likely to be more efficient than just generally tape-lifting a large area. As potential glitter particles are located they may be collected with tape lifts, although I personally prefer using Post-It® Notes. The glue on transparent tape is stronger and when you try to remove the particle from the tape it might be damaged in the process, and there is also a greater chance that some glue from the tape will be transferred to the glitter particle and may confuse subsequent characterization examinations. The glue on Post-It Notes is strong enough to remove individual glitter particles from most surfaces, and yet it is weaker, so that the particles can be picked off without damage and without transferring any of the adhesive material. The notes are also handy for writing down all the essential evidence documentation (case number, location where found, date/time, technician's initials, etc). If the unfolded Post-It Note is just slipped into a clear self-sealing plastic bag, the trace examiner back at the crime lab can perform a preliminary inspection using a stereobinocular microscope without even having to remove the Post-It Note from the plastic bag.

Location, location, and location! **Sometimes the location where trace evidence is found is every bit as important as the evidence itself.** ***Hypothetical scenario.*** **After work a young woman meets several of her girlfriends at a bar where there is music and dancing. The woman is wearing glitter as part of her eye makeup. A man she does not know asks her to dance and she accepts. However she gets bad vibrations**

and refuses additional requests after that one dance. She decides to go home and walks out to her car in the parking lot. She doesn't realize the man has followed her and just as she gets her car door open he grabs her from behind. He forces her into her car and follows in behind her. He then forces her to perform fellatio. Afterwards, he runs off. She immediately reports the assault. Investigators question the bar patrons and find an individual who knows the suspect and where he lives. The suspect is arrested and brought to a hospital where a SART nurse examines him. Standing over butcher paper he removes his clothing and as he does so several glitter particles fall to the butcher paper and are recovered as evidence. As the SART nurse then examines the suspect (takes penile swabs, etc.) she sees a pinpoint of light reflecting back at her from his pubic hairs. Using a Post-It Note she recovers a glitter particle from his pubic hair. Which will have the greater evidential value, the glitter recovered from the butcher paper when the suspect removed his clothing, or the glitter particle found amongst his pubic hairs?

IV. Variation and characterization of glitter.

Because of space limitations I will very briefly outline some of the many ways in which glitter may vary and describe appropriate tests that will characterize this variation.

a. Color. Some companies offer as many as 44 different colors. Does this mean that one can find 44 different colors if they examine <u>individual</u> glitter

particles? No. Glitter particles are so tiny that you can achieve just about any color you want if you <u>thoroughly</u> mix glitter particles of the appropriate different shades and in the right ratios. *Note bene,* the color of the glitter particles that you see *en masse* may not be the color of *any* of the individual particles as viewed under your microscope.

b. **Size. Several companies offer glitter in 10 or more sizes, starting from 0.002" (50 microns) all the way up to 0.250" (6250 microns). Size is easily measured using a calibrated reticule on your optical microscope. Hexagonal glitter particles are measured from one apex to the opposite apex, and square glitter particles are measured as the length of a side.**

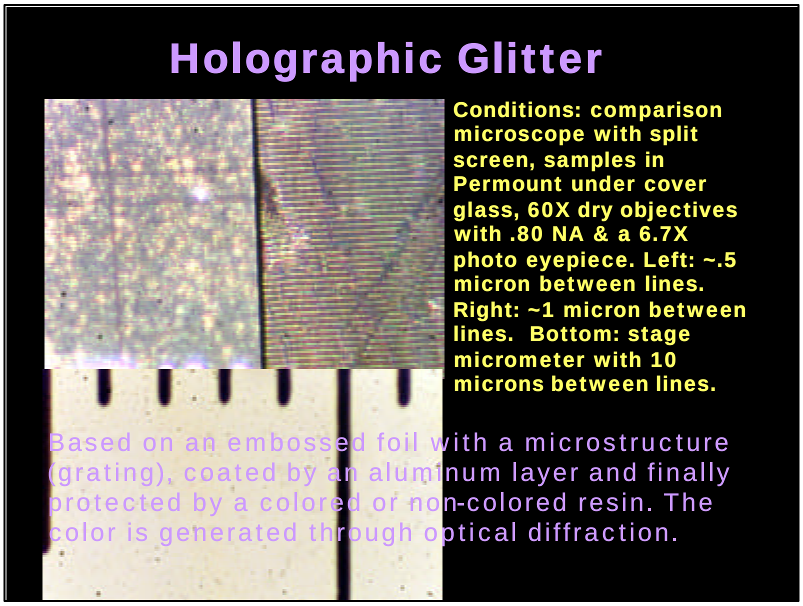
c. **Shape. Usually hexagonal (most common), square (next most common), or rectangular. Glitter particles are usually so small that it is not intended that an observer will be able to discern a shape; they only see a flash of reflected light. Glitter particles that are cut into shapes like stars or crescent moons are much larger and it is intended that a viewer will recognize the shape. In some products there will be a mixture of many small glitter particles and far fewer larger glitter particles that are in distinctive shapes.**

d. **Thickness. Glitter particles usually have at least three or more distinct layers. Even metallic glitter particles that consist of a single layer of aluminum will usually be coated on each side with a protective polymer layer. The world's largest glitter manufacturer, Meadowbrook Inventions [www.meadowbrookinventions.com] claims on their website to have in excess of 20,000 different glitter products, and they offer glitter in at least 8** different thicknesses ranging from 15 microns all the way up to 175 microns. Using calibrated thickness standards, determine with your optical microscope what change in thickness occurs per 360° rotation of the fine focus adjustment. With an individual glitter particle lying flat on the stage, get the stage in sharp focus. Move over to the glitter particle and see how much of a rotation of the fine focus adjustment is required to bring the top of the glitter particle into sharp focus. [Glitter particles often tend to stack like pancakes, so it is important that you are sure that you are only measuring the thickness of a single glitter particle.

e. Specific gravity. Because individual particles typically consist of several different layers of varying thickness of either metal (aluminum) and plastic, or just different layers of plastic, they vary in specific gravity. Meadowbrook Inventions offers glitter particles in 7 different specific gravities ranging from 1.2 to 2.5. Haven't used your sink/float apparatus on glass fragments in ages because you know that in glass refractive index and specific gravity are highly correlated? Take it out of your storage cabinet and try it on glitter particles!

f. Polarized light microscopy. So far, PLM hasn't proved especially useful.

g. Holographic glitter. Some glitters particles achieve their color through an optical effect produced by diffraction gratings. The distance between grating lines (another measurable characteristic) determines the color.



Very accurately measuring the space between grating lines on these holographic glitter samples would be a very helpful property for discrimination. Without resorting to oil immersion, these photomicrographs are at about the limit of practical magnification. Can't use SEM because the grating lines are not on the surface; they are covered with a thin polymer layer. Could one project a light beam from a laser onto the glitter particle (the grating lines are oriented at right angles to the beam), project the reflected beam onto a screen, measure the distance between spots on the screen, and then back-calculating the geometry come up with the distance between lines on the glitter particle?

h. ATR FTIR microspectroscopy

Glitter particles are either opaque (contain a metal layer) or even if translucent are optically too thick to give high-quality FTIR spectra either in transmission (even in a diamond compression cell) or in the reflectance mode. However, excellent, searchable spectra are produced when the attenuated total reflectance (ATR) diamond objective is used on an FTIR microscope. An additional advantage is that no sample preparation is required other than insuring that the surface of the glitter particle is clean. Bear in mind that glitter particles have two sides. The polymeric material on one side may be different from that on the other side. Some glitter particles have a separate coating on one side.

i. Dispersive Raman microspectroscopy with confocal imaging

In many respects Raman microspectroscopy may be the perfect technique for the chemical characterization of the various layers in a glitter particle. No sample preparation is required; it's non-destructive; and it is highly discriminating. If only the systems didn't cost roughly $150K! With confocal imaging and spectral subtraction one can identify polymeric surface layers as well as those (different) polymeric layers at greater depth. Confocal imaging doesn't work with glitter particles having one or more opaque metallic layers, but these particles can be stood on edge and the polymer layers can then be identified.

j. Vehicle

Cosmetic glitter is often contained and applied in some sort of vehicle (spray or roll on, lipstick, etc). For loose cosmetic glitter, wearers may first apply a thin layer of petroleum jelly so that the glitter particles will adhere and not as readily fall off. Glitter for arts and crafts may be in glues or paints. Glitter applied to fabrics for decoration must be held by some type of non-soluble adhesive. Although an area requiring more research, the potential exists that minute traces of the vehicle may still be adhering to recovered glitter particles and they too may be chemically characterized.

k. Cutting machine anomalies

If two different companies purchase their rolls of glitter film from the same manufacturer and then separately cut this film into individual glitter particles, their glitter particles should be chemically identical. However, due to differences in cutting machines it may still be possible to differentiate particles originating from the two sources. There have been several cases where many of the recovered glitter particles exhibited shapes that were less than perfect hexagons, and less than perfect squares (often have a tab that sticks up as with an index card). [See the Missouri case mentioned at the end of this paper.]

VI. *Review*: How close is GLITTER to the *ideal* contact trace?

1. **Nearly invisible. We normally don't actually see glitter particles; we just see the light they reflect. Suspects are not likely to be aware of their presence.**
2. **High probability of transfer and retention. Being light and small, glitter traces readily transfer.**
3. **Highly individualistic. We listed at least 11 ways that glitter particles may vary and can be characterized.**
4. **Easily collected, separated, and concentrated. Just need a flashlight and some Post-It Notes.**
5. **Mere traces easily characterized. Only a single glitter particle is required, although more particles would better argue against accidental transfer from a source totally unrelated to the victim or crime scene.**

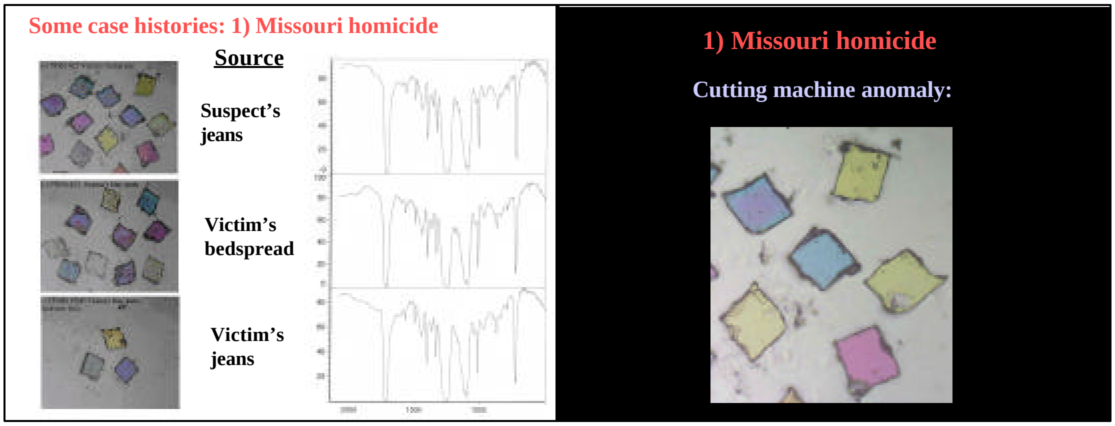
6. **Searchable via computerized database. Every property we have considered is capable of being measured and the results entered into a searchable database. As such a database grows from entries obtained from actual case examples, assessments of rarity become increasingly more reliable.**
7. **Will survive most environmental insults. Glitter particles have been found in auto carpeting after several years and could still be compared; also true of particles found in the hair of a dead body that had been exposed to the elements for weeks.**

By my score it is 7 out of 7. Glitter might even surpass carpet fibers as being the most nearly perfect contact trace!

VII. Three case examples

Glitter has already featured as important associative evidence in numerous cases. Case examples include three different glitter types: glitter in cosmetic products, glitter used in arts and crafts, and glitter used in decorations on clothing.

1. **Missouri homicide**



Notice one corner tends to be rounded and an adjacent corner tends to have a protrusion.

2. **Illinois kidnapping and sexual assault**

A derelict grabbed a young girl walking in woods near her home. With a knife he slashed her throat and her clothing, but she kicked him in the groin and escaped and ran home. Her mother rushed her to a hospital and the young girl survived. She had been wearing a shirt that had a design in silver-appearing glitter. A knife slash had gone right through this area. A suspect was found and glitter particles were found on several items of his clothing.

Left, cut through glitter design area of T-shirt. Right (top) glitter particle from victim's shirt and glitter particle recovered from clothing of suspect viewed as tape lifts and on separate stages of a comparison microscope. Right (bottom) same two particles after they have been picked off the tape and cleaned up.

3. Florida vehicle homicide

A highway in Florida had a center lane that was only supposed to be used for turning. A vehicle containing a mother and her daughter was stopped in this lane when a pickup truck driving in the center lane smashed into the stopped vehicle and both the mother and daughter were killed. When police arrived no one was in the pickup truck. However, an intoxicated woman was found hiding nearby in the brush. She denied being the driver, but she was wearing cosmetic glitter and at the instant of impact some of her glitter was transferred to the driver's side airbag.

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