3.6.1 History of Cyanoacrylate Ester Fuming (Superglue)

In Japan, a certain brand of Japanese super glue was packaged in a plastic container with a large transparent top. In 1977, a Japanese Forensic Scientist, Masao Soba noticed a white fingerprint on the inside of the transparent top. This started a Japanese research project. In 1978, two Americans from the U.S. Army Crime Lab witnessed a demonstration of the super glue research at Tokyo Metropolitan Police Department and brought the information back to the United States. Ed German and Paul Norkus were the first two to spread the information about the newfound properties of super glue.
It is also recorded that L.W. Wood, an officer from Northamptonshire Police in England found out about the fingerprint properties of super glue in may of 1979. He shared the information with the Midland Region Photographic and Fingerprint Officers' Conference. During this period, Paul Bourdon, a constable of the North Bay Ontario Police Force, discovered the technique and applied for both a United States and Canadian patents. He did this in 1980 after developing a re-circulatory chamber system.

3.6.2 What Superglue Is and How It Works

The active ingredient is called a "cyanoacrylate monomer" and is approximately 90% to 99% pure. This means no solvents are present in the adhesive. The most frequent additives in super glue are "polymerization retardants" and "viscosity thickeners". Super Glue was developed in the United States and was originally called "Eastman 910 Adhesive". There are various forms of the adhesive, the most common being ethyl and methyl monomers, with ethyl being preferred for fingerprint development. When the liquid cyanoacrylate is used as an adhesive, a chemical reaction takes place, which is called polymerization. What happens is that the molecules of the cyanoacrylate rapidly bond together forming a chain-like configuration usually in the absence of air. Because the adhesive is so reactive, it has an undesirable property of polymerizing on itself in the presence of heat, moisture or organic contaminants. Substances called polymerization retardants are added to the cyanoacrylate to prevent this from happening while the adhesive is being manufactured or stored in a container.

Basic yellow 40 dyed superglue on a drinks can

This same polymerization process occurs when the glue is used to develop latent fingerprints, except that the glue is used in a vapor form and in a vapor form the glue is free of polymerization retardants, and is much more sensitive to traces of moisture and organic contaminants. Because fingerprint residue is

comprised of moisture and organic substance, the molecules of the glue rapidly attach themselves to the fingerprint residue. Then more molecules of the glue vapor react with the already attached molecules adhering to the fingerprint residue.
A recent research article from England by the Police Scientific Development Branch points out that British Scientists took electron microscopic photographs of super glue developed prints. They found that the glue attached itself as long strands to the fingerprint residue much like the long fibers of a carpet. They also verified that moisture plays an important role in the development of the fingerprint. For fingerprint development, they found that the optimum relative humidity was determined to be about 80%. The super glue would react poorly with low humidity levels and react ideally with a relative high humidity level. Conversely, it would get poor results due to background interference at too high of a humidity level.
That is why, that with all the techniques described, a cup of warm water (approximately 50 C) should be placed in the fuming chamber before the fuming process begins. It should be noted that in certain instances, no warm water should be used at all. It is suggested that some kind of humidity-recording device be placed in the area where the processing of fingerprints is normally performed. That should be the determinant for adding additional humidity to the fuming chamber.

3.6.3 Superglue Safety and Handling

Cyanoacrylate adhesives are all clear liquids at room temperature. They are considered to be lachrymators, that is, they can cause extreme eye and nose irritation. That is why Super Glue fuming should be performed in a well-ventilated area. Either in a fume hood (laboratory type) or an exhaust fan should be used close to the fuming area.
If a quantity is accidentally spilled, it should be immediately treated with water, in order to rapidly cure-out the glue, which will reduce the potential of generating the irritating fumes and also prevent the glue from adhering to other objects. This, most frequently, is fingers or other areas of skin. This is another hazard of cyanoacrylate usage, since the adhesive is considered a skin bonder, and has been used in dental and other medicalapplications.
If accidental skin bonding occurs, you should have one of several commercial cyanoacrylate solvents available. If not, there are several solvents common to most laboratories that work with various degrees of effectiveness. Some are: nitromethane, MEK (methylethylketone), acetone, and acetonitrile in water. This is prepared by mixing two parts acetonitrile with one part water. This acetonitrile-water mix not only removes the glue from the fingers but is excellent on clean up of fuming chambers, as well as cleaning up of glue residue on items of evidence, from guns to valuable jewelry.
Cyanoacrylates (CA), if not in current use, should be refrigerated. This prevents the glue from prematurely curing out and becoming a solid mass and losing its effectiveness. If not refrigerated, a bottle of super glue will last approximately from 6 months to one year, depending upon room conditions. To extend the shelf life even longer, when you purchase more than you can effectively use in 6 months, place the unopened bottles in a freezer. However, after being removed from the freezer (same for refrigerator stored bottles) the bottle should be allowed to set and adjust to room temperature before opening the container. This may be from one to three hours.

3.6.4 When to Use Superglue

It was initially felt that the CA technique was just for difficult surfaces, such are greasy or oily contaminated surfaces and textured surfaces (i.e. phonograph records) or for latent prints which are weeks old. After years of use, experimentation, and numerous articles documenting CA successes, it is now an accepted technique for practically any nonporous surface. To determine porosity, try to visualize if

a droplet of water will be absorbed on the surface. For example, a droplet of water will roll off metal, glass, plastics, glazed paper (glossy magazine pages), and finished leather surfaces (wallets, glossy holsters, etc.), while a drop of water would be absorbed on newspapers, checks, unfinished leather surfaces, and raw wood.

Because of its unique property of making a latent print more durable, and one that is less likely to be rubbed off, the U.S. Army Criminal Investigation Laboratory in Europe developed a policy for their field agents of making CA fuming mandatory, prior to shipment to their crime laboratory for all nonporous evidence for fingerprint examination.

As a result of that policy, a statistical survey was conducted of cases, which were CA fumed and submitted to the laboratory. The results were so impressive that a paper was prepared and presented at the 1990 International Association for Identification conference in Nashville, Tennessee by William M. Thomas, chief of their latent print division.

They found that over two hundred percent more latent prints were developed on items fumed prior to submission to the laboratory. The most noticeable surfaces were plastic bags and ATM cards (credit-type cards). This durability, however, has a drawback. Not only does it secure the fingerprint to the surface, it also does the same to contaminants on the surface. This could possibly coat items and damage them, i.e.: camera lens, other types of optics, electronic instruments, etc., and will leave a coating on vinyl car seats and windshields. Prudent judgment should be used as to whether the possible damage the fuming could cause outweighs the severity of the crime. For example, a car should not be fumed in the case of auto theft or tampering.

Another important point is that it will be more time consuming to fume items at a crime scene location. Therefore, freshly handled items, which have surfaces that are conducive to good prints are better processed with fingerprint powder and lifted, such as broken window glass at a burglary scene where there appears to contaminants on the glass surface.

This information should influence the decision as to whether fuming should or should not be used at a crime scene. These questions should be asked:

- Will there be difficulty in submitting the evidence to the lab or identification unit?
- Will there be a chance that the evidence could be rubbed against either other items or the packaging material itself?
- Does the surface have trace amounts of suspected drugs present, and if so, will it be important for the suspected drugs to be analyzed?
- Does the surface have blood or other biological fluids present that may be examined at the laboratory?
- Will the surface be analyzed for trace evidence, such as hairs, fibers, or gunshot residue?
- Is a patent fingerprint present? This is a latent fingerprint that is visible to the naked eye. These should be photographed first, before any processing (CA fuming or powdering) is attempted.
- Is there is any doubt that some other form of evidence may be present which may also need to be analyzed?

The item or items not to be fumed at the scene, but need to be submitted to the crime lab should then be packaged in a manner, which would prevent the accidental rubbing against the sides of the container. Plastic bags are the poorest evidence containers for nonporous fingerprint evidence. There are no standard fingerprint evidence containers. It depends upon the nature of the evidence and the resourcefulness of the crime scene examiner. In many cases, a clean cardboard box will suffice.

3.6.5 Fuming Chambers

The most economical chamber is a clear plastic bag. The size of the bag depends upon the size of the evidence or items to be fumed. A more efficient, re-usable chamber is a fish aquarium, a 5 gallon tank for small items, and a 30 gallon tank for larger items.
The aquarium is modified slightly by:

- Applying weather stripping (3/8" thick) along the top of the tank, so that a plate glass lid, when placed on top of the aquarium, will form a relatively airtight seal.
- Covering the back, two sides, bottom and top of lid with aluminum foil. A thin film of Vaseline (petroleum jelly) is all that is needed on the backside of the aluminum foil to make it adhere to the sides of the chamber.

The aluminum foil reduces the build-up of CA on the chamber and also eases the cleanup of the chamber, since only one side (front side) has to be cleaned. Cleaning is accomplished with either a razor blade scraper or commercial cyanoacrylate remover, or one of the suggested solvents, such as the acetonitrile-water mixture.
Build-up can further be reduced by either using clean gloves when handling the foil or wiping off the foil with cotton, saturated in rubbing alcohol, to remove fingerprint deposits, after the foil is applied to the chamber sides. The foil in the chamber can be replaced easily and should be after thirty or forty fuming processes. More frequently if too much cyanoacrylate is used.
In a pinch, even a cardboard box can be used as a makeshift chamber, but should only be used once, since glue build-up will occur after one use. For very large items, a tent can be made out of clear plastic sheeting and taped down with either duct tape or wide masking tape. If the plastic sheeting caves in and makes contact with the evidence to be fumed, some sort of framing will be necessary. A novel way of making a large fuming chamber is by using PVC plastic pipe, from ¾" to 1 ½" I.D., and putting the pipe together with PVC joints and elbows like a tinker toy set. Some departments have made crime scene kits consisting of plastic pipes, fittings, and large plastic (polyethylene) sheets. For example, to fume the outside of a car, 1 ½" PVC piping is placed around the vehicle in the shape of a large rectangle with the aid of PVC fittings, and plastic sheeting is placed over the framework, with weights placed where the plastic touches the ground to make a better seal for the cyanoacrylate vapors.
Another inexpensive fuming chamber is an old refrigerator. It can be modified for routine indoor use by connecting a vent hose to an opening cut in the back and exhausting the fumes outside with the aid of a bathroom type blower once the fuming is completed. Commercial fuming chambers are available, from collapsible, clear plastic ones to expensive, temperature and humidity controlled chambers costing hundreds of dollars.

3.6.6 Superglue Techniques

3.6.6.1 Chemical Acceleration

In this type of technique, the CA is poured on a chemically treated pad and a chemical reaction takes place between the CA and the pad which generates heat (an exothermic reaction) and volatilizes a portion of the glue off. The advantage of this technique is that it can also be used at a crime scene, using a minimum amount of time. This would be used on a small immovable object, i.e., a doorknob. A plastic bag could serve as a chamber.
One disadvantage is that most of the fuming process takes place in a short amount of time and it has been found that certain types of surfaces are more receptive to a slower, longer fuming procedure, such as rubber gun grips, wooden gun stocks. These surfaces seem to respond to a longer fuming process (10

minutes or longer). This is not to say that the item cannot be re-fumed a second or third time. The only drawback to re-fuming with accelerator pads is that the print can be overdeveloped and contrast lost due to coating of the background. Another disadvantage is that the treated pads have to be made in advance, or purchased. Most of the CA is being used (90%) to generate the heat. Therefore, the processes are not the most efficient use of CA. The following are three "do-it-yourself" chemical acceleration techniques.

3.6.6.1.1 Frank Kendall Technique:

Supplies needed: Absorbent cotton batting, sodium hydroxide (lye or caustic soda). Cyanoacrylate adhesive, lower the viscosity, the quicker the reaction time. Ethyl or Methyl monomers will work equally well.
Procedure: Dissolve one ounce of the sodium hydroxide in one quart of water, then place approximately a 12" square of the cotton into the solution. NOTE: Wear rubber gloves, because the solution is very caustic. Wring out the cotton and allow to dry overnight. When dry, cut into 2" squares. The pads can be stored either in a zip lock plastic bag or a heavy brown envelope. The pads are now ready to be placed in a fuming chamber and quickly treated with approximately one teaspoonful of liquid CA.

3.6.6.1.2 Technique suggested by Permabond Inc.:

Supplies needed: Sodium bicarbonate (baking soda), cotton balls, and water.
Procedure: Dissolve a quantity of baking soda in a quart of water until no more will be dissolved. Next, place a quantity of cotton balls in the solution. Then remove and squeeze out the water (solution is safe, no need to use rubber gloves) and allow to dry overnight. These treated cotton balls will generate fumes in 30 seconds after applying 1 teaspoon full of CA to the pad.

3.6.6.1.3 William C. Sampson Technique:

Supplies needed: Sawdust, Baking soda, zip lock sandwich bags.
Procedure: Mix one teaspoon full of baking soda in a zip lock sandwich bag and add two teaspoonfuls of sawdust to the same bag and seal and shake until evenly mixed. Place one teaspoonful of the mixture on a small piece of foil inside the fuming chamber. Add one teaspoon of liquid CA on top of the mixture. Fuming will start in approximately 30 seconds, depending on the temperature of CA. Cold CA will delay the reaction time.

3.6.6.2 CA and Heat source

These techniques involve the use of some type of a heat source, either a light bulb, coffee cup warmer, hot plate, modified soldering iron, or a modified hair dryer to volatilize the CA off, the critical part being a temperature range of 90 degrees C to 110 degrees C.

3.6.6.3 Increasing the Surface Area of the CA

This technique involves the spreading of the CA out as a thin film so the liquid adhesive can evaporate more rapidly. This was commercially developed by Locktite Corporation and sold as "Hard Evidence" Pads, with several replicas on the market. To make your own, which will generate CA fumes as well as the commercial products, just cut a piece of aluminum foil (heavy duty type) 15 cm x 20 cm (6" x 8") and make a widthwise crease down the middle.
A cyanoacrylate (a high viscosity methyl monomer works best, such as Permabond #170 or 3M's CA 50 GEL) is placed on the foil, midway between the crease and the edge of the foil, and 12 mm (1/2") in from the edge. The foil is folded over onto the cyanoacrylate bead, and a fingerprint ink roller or similar

cylindrical object is rolled on the foil to evenly distribute the CA. Items to be fumed should be positioned in the chamber first, along with a cup of warm water - depending on the humidity level. The fuming process starts as soon as the foil is pulled apart. Some latent prints will be developed in 10 min. The CA treated foil should never be left in a small chamber for more than 30 minutes, because over development will occur. Fuming time not only depends on humidity, vapor concentration, and chamber size, but the chamber temperature and the ability of the CA vapors to distribute evenly throughout the chamber. To help distribute the vapors evenly inside a vehicle, if possible, turn on the heater fan before the fuming pouches are opened.

3.6.6.4 Vacuum Chamber Technique

This relatively new technique was developed by a Dr. John Watkin of the National Research Council of Canada. It consists of placing the evidence to be fumed, plus a small quantity of liquid CA in a vacuum chamber, a vacuum of 20" Hg can be adequate. The evidence should be held in the chamber for 20 minutes. Presently there are several companies selling commercial vacuum chambers. Cost from several hundred dollars to thousands of dollars.

The advantage to this method seems to be the ability of the CA to permeate into closed plastic bags and develop prints on inner bags. In one demonstration, prints were placed on one plastic bag, then rolled up and placed into a second plastic bag. The second plastic bag was then rolled up and placed into a vacuum chamber. After 10 minutes at a high vacuum, the bags were removed and then dye stained. The prints looked as good as inked impressions. Another advantage is that it is almost impossible to over develop the latent prints, and there is less background contamination, that is, less of a CA residue buildup on the substrate.

The drawbacks to this process are the initial cost of the system, and that many of the developed prints are not visible to the naked eye, and therefore have to be processed with a fluorescent dye and examined with either a high intensity UV light, laser, or alternative light source. The results then have to be photographed in order to be preserved.

3.6.7 Safety Considerations

This procedure involves hazardous materials. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution should be exercised and the use of personal protective equipment should be considered to avoid exposure to dangerous chemicals. Consult the appropriate MSDS for each chemical prior to use.

Rapid volatilization, however, presents very serious health risks. High heat volatilization can produce hydrogen cyanide, which is toxic even in small concentrations. Lower temperatures appear relatively safe and only increase development time by a matter of minutes. Chemically produced vapors are highly irritating and repeated contact with moist eyes can result in polymerization on the eye itself. Contact lens wearers are especially cautioned to avoid prolonged exposure to the fumes.

3.6.8 Minimum Standards & Controls

The Standards and Controls for cyanoacrylate ester fuming procedure requires the use of test impressions. Aluminum foil, microscope slides, or clear plastic latent lift backers are convenient substrates when deliberately deposited with a test impression and placed near the evidence. Processing should be terminated when test impressions have reached optimum development. However, all items should be watched carefully as faster or slower development may occur. Exposure of surfaces to a high

concentration of fumes can result in overdevelopment, which obscures impressions due to total surface polymerization. Test impressions must be done with each batch of items processed. Documentation of the test impressions must be done in the control drop down box in the case record worksheet.

3.6.9 Interpretation Of Results

Photographic preservation of all suitable polymerized impressions is recommended prior to any additional processing. Once the latent impressions are recorded, further processing sometimes reveals impressions in which polymerization was too indistinct for visual notice or did not occur. Powders and particulate developers are effective and often permit additional photographic and lifting preservation. Small particle reagent (SPR) will sometimes adhere to faint impressions when powders will not. Laser dye and/or Ardrox P133D application is generally effective after powder, particulate, or SPR application as the liquid dye solution will normally wash away the particulate remnants. However, vinyls, rubber, oily guns, and hard plastics, especially those used in cash register drawers, may not be receptive to any powder or particulate method.

3.6.10 Minimum Quality Standards And Controls

See Standards

3.6.11 References

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