M.G. Chemicals Ltd.

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PRESENSITIZED BOARD OR PCB CHEMICALS

Positive Photo Resist Photofabrication Technical Manual for printed circuits

INTRODUCTION

The widespread commercial use of "printed circuits" in electronic equipment began a few short decades back when engineers started looking for more efficient wiring techniques to replace the laborious and expensive hand-wiring methods used at the time.

One of the first methods tried was the deposition, or printing, of a conductive ink pattern on a base of insulating material. Other methods were developed later, including the use of die-cut foil patterns. The original method ... printing ... gave its name to all subsequent methods, regardless of the production techniques used.

Today, then, the term PRINTED CIRCUIT refers to any electrical circuit in which individual wire lead connection have been replaced by two dimensional conductive patterns bonded to an insulating base material.

In practice, most present day printed circuits consist of etched copper foil wiring patterns bonded to any of several insulating base materials (or substrates). A self-contained circuit pattern is termed a circuit board. Generally, these are sturdy enough to serve as mounting bases for the actual electrical components (resistors, capacitors, transistors, coils, and so on) which make up the circuit.

Although originally developed for mass production applications, printed circuit fabrication techniques have been until they can now be used by almost anyone with average mechnaical skills.

Whether you're a student, a hobbyist, an experimenter, a home "do-it-yourselfer" or a practicing technician or engineer, you can turn out professional quality printed cirucit boards every bit as good as those used by the giant electronics equipment manufacturers. Easy-to-follow step-by-step instructions are detailed on the following pages, while all the materials and supplies you'll need are available from your nearby electronics parts distributors.

SUBSTRATE PRE-TREATMENT-CLEANING

Proper pre-cleaning is vital for good imaging & etching. Clean the copper surface using synthetic scrubber & plain pumice to obtain a bright shiney surface. Rinse thoroughly. Insure that the copper surface is clean by checking for a water break-free surface. Drying with heat is recommended. Synthetic scrubbers and plain pumice are available in hardware stores. After cleaning avoid any contact with cleaned copper surface.

COATING YOUR BOARD

Boards must be coated under dark room conditions. Use in a room with a low light level, a 25 w incandescent bulk 10 ft. away, better yet a 25 or 40 watt red or yellow bulb. Lay the board on a flat level surface with absorbent paper underneath.

AEROSOL SPRAY COATING

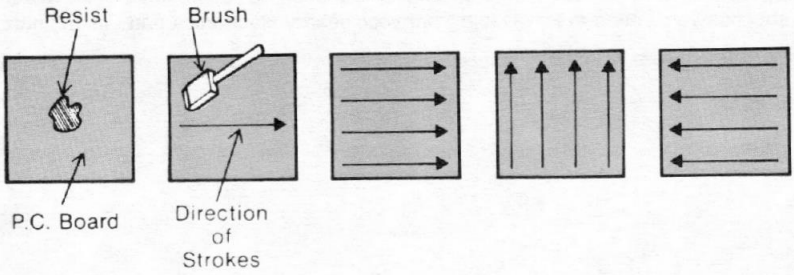
Hold the can 20cm (8") above the board and spray an even coating the length of the board approximately one quarter the width of the board. Use an MG 416 resist smoother to smooth the photo resist evenly across the board until no bubbles appear.

LIQUID COATING

Dilute a small amount of MG 416 liquid photo resist 1 to 1 with MG 417 thinner/cleaner. Pour a trip down the length of the board Smooth evenly across the board with a MG resist smoother until no bubbles appear. Approximately 15 ml of thinned photo resist will cover a 6" by 6" board.

USE OF A MG 416 RESIST SMOOTHER

It is essential that the coating of photoresist applied to the board be very thin and completely even in thickness. The thickness of this coating is proportional to the exposure time required, and affects all other processing steps as well. An uneven or thick coating will make it impossible to produce a satisfactory board. Fortunately it is quite easy, with a little practice, to produce a proper coating. It is a good idea to coat more board than you need right away, and store the rest wrapped up in an opaque material.



DRYING

Air Drying – lay the coated board flat in a dust free dark area for 24 hours at room temperature.

Heat Drying — you can speed up drying by blowing the board with a hair dryer or heat gun set on a low temperature providing the resist surface is dry to touch. Caution should be used as dust particles can be flown onto the resist surface.

A second method of heat drying is to softbake in an oven at a maximum temperature of 180°F (82°c) for 20 — 30 minutes. Ovens should have a fresh air flow per minute capacity, about equal to their volume, to ensure adequate solvent removal. Boards should be shielded from direct heat and light of oven elements.

If you are making a double-sided board, start by cleaning both sides. Then coat and dry one side of the board at a time. When coating the second side, be careful not to allow any wet photoresist onto the dry side.

USING MG SERIES 600 PRESENSITIZED BOARD

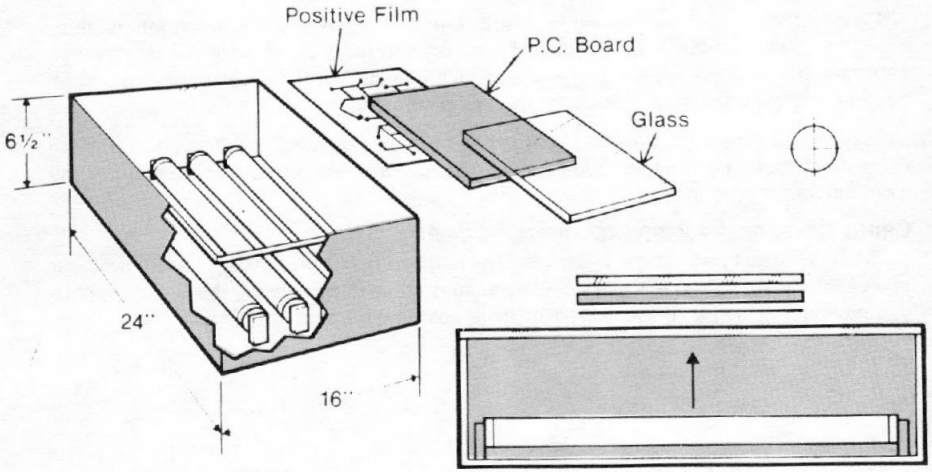
All the preceeding steps can be eliminated by purchasing MG presensitized board available in a variety of sizes. The following directions are for use in completing the board whether you have purchased it presensitized or have coated the board yourself.

EXPOSING YOUR BOARD

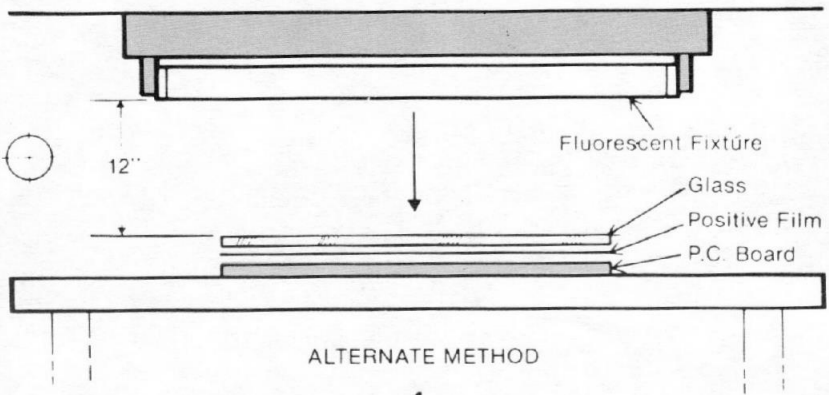
MG photo resist must be exposed with a long wave ulta-violet light with wavelength of about 375nm. An ideal inexpensive light of this type is unfiltered fluorescent ultra violet black light, part number F15T8BL. A nominal exposure time is 3 to 5 minuite at a distance of 4 to 6 inches.

Decorative black-light tubes will not work properly. A sunlamp will work, though the exposure times are longer since the light must be a minimum of 15 inches away from the surface of the resist. If you do use a sunlamp, remember to wear eye protection, because it produces dangerous short wave ulta violet light as well.

If you plan to make p.c. boards regularly, you may want to assemble an exposure box, as shown below. Using more than one florescent tube will produce more even exposures in less time. The exposure can also be done without a box, with one tube and a piece of glass. Simply place the film positive on the coated board, and cover them with a piece of 3mm glass. Position the fluoresecent tube just far enough away to given even illumination to the board, probably about 20cm (8") for a small board.



EXPOSURE BOX



ALTERNATE METHOD

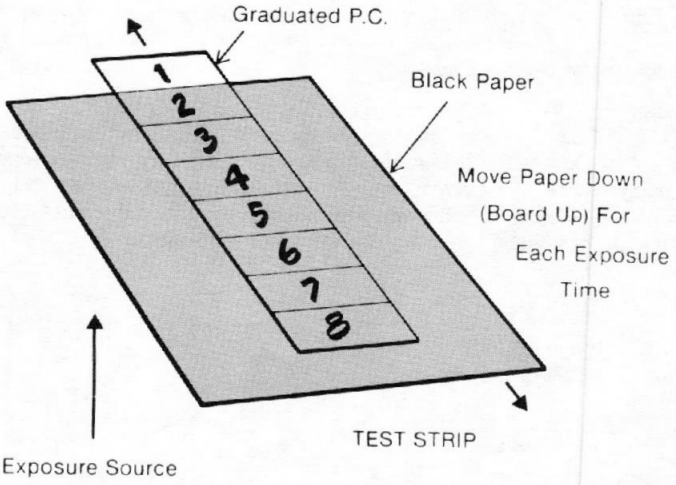
EXPOSURE (cont.)

There are a few special tricks to exposing a double sided board which will ensure that both sides are properly lined up. First tape the film positive onto one side of the board. Then carefully drill two registration holes through pads at opposite ends of the board. When drilling through the film positive and the board, be sure not to scatch the coating on the second side. After drilling the holes, blow off any dust on either side of the film or the board.

Before exposing a double-sided board, be sure you have tried and perfected the exposure and development processes. Check that the film positive is properly registered to the registration holes on the first side of the board, and expose the first side. Then register the second film positive on ther other side, and tape it down for the exposure.

In order to get your coating, exposure, development and etch systems worked out you will probably have to make a few unsuccessful boards. A mistake at any stage in the process can result in a bad finished board. Because of this, a good strategy is to try keeping most factors constant while varying one specific process. If a board doesn't turn out, don't change the exposure setup, coating thickness and development time all at once on the next try, because you'll never figure out what you're doing wrong.

The best approach to determining the optimum exposure time is to make a step-exposure. This will produce a single board with a range of eight different exposures.



Use a permanent felt pen on the back of the unexposed board to divide it into eight different sections. Using one of the exposure lamp systems described, use a piece of black paper between the film positive and the light to change the exposure in 1 minute increments. Start with the board 1/8th uncovered, and a 1 minute exposure. Then move the paper back to expose another 1/8th for 1 minutes. Repeat this process, and in eight minutes you will have produced a test board with eight different exposures on it. After developing the board you will be able to choose the correct time to use with future boards. If a 5 minute exposure seems to work, try another step exposure with 30 second increments around 5 minutes.

Leave the p.c. board in the etchant until all the unwanted copper is gone. If the board is left too long, thinner traces will start to disappear. Remove the board from the etchant, wash it thoroughly under running water, then dry it or let it dry.

Another stategy for agitating the etchant is to use air bubbles. Buy two long "blue air bubble wants" and an air pump from an aquarim supply store. These wants come with suction cups which, if put onto an extra piece of p.c. board, will hold the wands under the board to be etched. The bubbles from these wands will faciliteate the action of the etchant. Do not use aquarium "air stones".

After the board has been washed and dried, clean the remaining phtoresist off the board with MG 708 photo resist stripper.

Tin Plating your Board

Tin-plating the copper traces on your P.C. board is fast, easy and inexpensive with MG #421 Liquid Tin solution. Just pour the solution, undiluted and at room temperature, into a plastic or glass tray. Do not use a stainless steel tray! Immerse the clean board into the solution for 3 to 5 minutes. Rinse the board with warm water, and dry it. The tin-plating will make the board easier to solder, and prevent oxidation of the traces.

Your board is now finished and ready to have components soldered into it. Be sure to use a low-wattage soldering iron and rosin-core solder. Do not, under any circumstances, use acid-core or plumbers solder.

Warning:
#421 Liquid Tin is corrosive and contains flouboric acid. Do not store near basic solution (such as *418 Developer). Wear rubber gloves while using it. As with any dangerous chemical, wear goggles or other eye protection. Avoid contact with eyes and skin. If splashed in eyes or on the skin, flush thoroughly with water. If swallowed, give three to four glasses of milk or water. **Do not** induce vomiting. Call physician immediately.

DEVELOPMENT OF YOUR BOARD

The development process removes any photoresist which was exposed through the film positive to ultraviolet light. The exposed board should be developed in a plastic or glass tray with Developer. Developers for other types of photochemistry will not work. Photographic trays and tong available from camera stores are ideal. Developer is easy to use, but note the warning below.

Warning:
Developer is a corrosive alkali. Wear rubber gloves while using it. Avoid contact with eyes and skin. Do not store it near acids (such as #421 Liquid Tin solution!). It contains sodium hydroxide (also known as lye). As with any dangerous chemical, wear goggles or other eye protection. If splashed in eyes or on the skin, flush thoroughly with water. If swallowed, give three to four glasses of milk or water. **Do not** induce vomiting. Call physician immediately.

Make up a tray of developer solution by diluting 1 part MG 418 Developer with 6 to 8 parts lukewarm water, approx. 30°C.

Using rubber gloves, insert the exposed board copper side up into the developer. As the image develops you will see clear lines. When you see the pattern clearly, remove the board from the developer. A typical development time might be 2 to 3 minutes. Wash the board for about a minute under running water, the same temperature as the developper. After washing, the board can be put directly into the Ferric Chloride etchant.

If you are working with a double-sided board, you may find that one side develops faster than the other. Be careful not to scratch the coating on the bottom side of the board during development, washing or etching.

If you cannot get a satisfactory image, then either the developer is worn out, you have not left the board in the developer long enough, or the exposure was too short. If this happens, you can try re-developing the board. If all else fails, just wipe off the photoresist with MG 417 Thinner/Cleaner, re-coat the board, and start again.

To remove exposed resist which has turned purple. If all purple has not been removed through washing, swab gently with developer soaked cotton swab and rinse thoroughly.

To minimize undercutting and pinholing the unexposed resist can be gently warmed by a hairdryer or heat gun set on a low temperature from a distance of 4 to 6 inches for one to two minutes. This should be done just prior to etching.

ETCHING YOUR BOARD

The most popular etchant is Ferric Chloride, an aqueous solution which dissolves most metals. This solution is normally heated up during use, generating unpleasant and castic vapours, it is very important to have adquate ventilation. And now the official cautions about #415 Ferric Chloride:

Danger:

Use only glass or plastic containers. Keep out of reach of children. Harmful or fatal if swallowed. May cause burns or stain. Avoid contact with skin, eyes or clothing. Store in a plastic container. Use adequate ventilation. As with any dangerous chemical, wear goggles or other eye protection.

Ferric Chloride can stain ceramic, procelain and stainless. It is a corrosive chemical, so use care when disposing of this material.

In case of contact with eyes, flush immediately and thoroughly with large amounts of water, then rinse with a weak solution of sodium bicarbonate or boric acid. Consult physician immediately. Flush skin and spills with water. If swallowed, drink large amounts of water or milk. Do not induce vomiting. Call a physician immediately.

If you use Ferric Chloride cold, it will take a long time to etch the board. To speed up etching, heat up the solution. A simply way of doing this is to immerse the Ferric Chloride bottle or jug into hot water, adding or changing the water to keep it heating. Be careful not to overheat it. The absolute maximum working temperature is about 65°C (150°F), at which a board etches in 3 minutes. Fresh, room temperature etchant will take about 10-15 minutes.

The warmer your etch solution, the faster your boards will etch, but the more noxious fumes you'll have to put up with. Ferric Chloride solution can be used over and over gain, until it becomes saturated with copper. As the solution becomes more saturated, the etching time will increase. For reference: one litre of solution can etch all the copper off about 3.7 square feet of 1 oz. board.

After heating the Ferric Chloride solution, pour some into a plastic or glass tray. One effective way to help keep the solution warm is to use two trays, one within the other. The outer tray is filled with hot water, and the inner tray with etchant. Place the developed board into the tray, image up. Rock the tray gently from side to side continously during the etching process. This clears away the dissolved copper, enabling the etchant to continue working properly on the remaining copper.