

# The Possibility of Using Acrylic Plates to Replace Copper Ones *in Intaglio Printmaking in Thailand*

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## Abstract

This research's aim is to experiment with acrylic plates in the four Intaglio Printmaking processes of Drypoint, Hard Ground, Soft Ground and Aquatint as an alternative to the normally used copper plates, which are more expensive and must be purchased from a specialized vendor, and its processes involve the usage of chemicals that may affect health. Experiments in this research show that using acrylic plates with alternative processes can reduce intricate workflows, reduce workspace and costs involved, since this process requires less equipment and materials to be used, and more importantly reduce chemical consumption. Thus, making it beneficial for artists, art schools, the community and individuals who have an interest in alternative printmaking processes of this type.

**Keywords:** *Printmaking, Alternative Printmaking Processes, Non-Toxic Printmaking, Intaglio Printmaking, Etching, Thailand*

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## Introduction

In Thailand, the use of various printing techniques has been used since the time of cave art i.e., Prehistoric handprint on cave wall, Mae Moh district Lampang and various aspects of the technique have been developed and used with various other artifacts throughout the history until the reign of King Rama V of the present dynasty, craftsmen devised a technique well known to printmakers today for making Woodblock to print on cloth. And then after the first National Art Exhibition was held in 1949 and annually afterwards, and consequently, Printmaking excellence prize was also included in the Exhibition since 1961.

Traditional fine art printmaking process normally consists of 4 keys types, which are:

- Relief Printing, where images are printed using the raised areas of the printing block.
- Stencil, where images are obtained through the use of cut-out stenciling.
- Planography, as in Lithography, where images are printed by using a chemical reaction of Gum Arabic with the surface of the substrate.
- Intaglio, where images are printed from the ink in the groves on the printing plate.

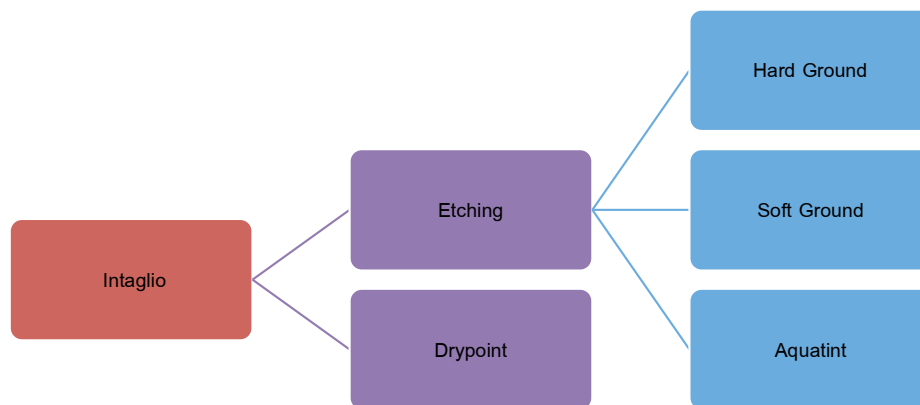


Figure 1. Diagram of Intaglio Processes, Source: Author (2022).

## Modern Thai Printmaking

As a result of the formal establishment of Silapakorn University-the country's first university dedicated to the teaching of Art in 1943, Fine Art Printmaking in Thailand has officially started its first stage of development from around 1963 until 1977 and has gained more acceptance internationally from then on until the present day (Pishnu Supanimit, 2003). And since the researcher is also a part of this present-day movement as an art educator, finding ways of using less chemical and alternative printmaking process has been priority concern. Thus, various alternative materials and processes have been tried out. Especially those used in the Intaglio Process, Therefore, this article will emphasize on the alternative intaglio processes from the writer's research findings.

## Etching

Etching, as part of the Intaglio process, has been traditionally done on metal plates such as zinc or copper, where asphaltum or rosin plays an important role as an acid-resistant ground (Magical Secrets, n.d.) in coating the surface. After being coated, the design is then scratched or pressed into the ground, exposing the metal in the desired areas. Then, the plate is submerged in an acid solution until the desired depth and width in the exposed areas are reached (Britannica, n.d.). Both metal plates, especially copper, have a relatively

high unit price. In addition, in the etching process, acidic chemicals of various concentrations are used, thus, requiring the proper arrangement of the operating area, and safety precautions must be taken in the process (Graver, n.d.).

In this regard, the researcher has preliminary information about the possibility of using acrylic plates in the Drypoint process (Stead, n.d.) and has experience from the experiment. Therefore, this research is an experiment on acrylic sheets used as plate, and the solubility of Dichloromethane to replace the use of acid in the etching process. Some outstanding properties of the acrylic sheets, such as the density of 1.15-1.19 g/cm<sup>3</sup> which makes them resistant to impact, more resistant to the environment than other plastics, and can be dissolved with varieties of solvents. Moreover, the transparent acrylic sheet allows 92% of light to pass through it (ChaiCharoenTech, M.P.A.), thus, making it convenient for the Printmaker to overlay the plate over sketches or prototypes for duplication. Drypoint scratches on the plate can also be created easily because the material is flexible and not rigidly hard.

As for handling, it can be easily maneuvered around the studio during the working process since it is lighter than the copper plate. Moreover, the alternative solvent used to replace the acid used in the typical Etching process, the researcher has chosen Dichloromethane, owing to its ability to dilute the surface of the acrylic sheet effectively, and therefore, is commonly used as a solvent for binding surfaces of acrylic sheets together. Thus, making it easy to access via general acrylic sheet vendor. Apart from that, the substance is also one of the least harmful Chlorocarbon compounds, with the least toxic Chlorohydrocarbon and volatile properties (Pollution Control Department, 2008). Therefore, with the above mentioned, the researcher has further experimented with the possibility of forming various grooves on the acrylic plates by applying Dichloromethane as a dissolving solution to perform the Etching-like result made from the etching process on metal plates.

### Methodology

Normally the ground in etching is any acid-resistant material used to protect an etching plate from acid. The most common grounds are wax, asphaltum, shellac, rosin, and soap. To print an intaglio plate, you fill the marks with ink and wipe the surface clean. The press pushes the paper into the inked lines (Magical Secrets, n.d.)

Hence, the researcher has applied this concept to the use of an acrylic plate for the etching. But rather than using the typical acid versus acid-resistant ground in the metal plate etching process, the researcher has applied a solvent versus an anti-solvent ground for this research. In the experiments, Dichloromethane was used as a solvent to create grooves and lines in the design on desirable areas, while it does not strip or dissolve the anti-solvent ground used to coat the plate. The use of Dichloromethane can be applied because the particles of solutes break down into tiny particles and infiltrate another substance (solvent) depending on the intermolecular force between the solvent and the solute molecules and the intermolecular force between the molecules of the solute and solvent itself.

According to the "like dissolves like" principle, polar solutes dissolve in polar solvents due to the interaction of their dipoles, however, this is not possible with non-polar solvents (Pimdee, 2017). Moreover, after trying out several anti-solvent grounds, the researcher found that Winsor screen filler (Handprinted, n.d.; Winsor Group, 2017) can resist Dichloromethane from dissolving the acrylic surface. Thus, this concept has been applied to replace the use of acid and acid-resistant ground in three etching techniques: Hard ground –

a technique which uses etching ground melted from a ball or cake onto a heated plate and spread while soft by means of a roller or dabber and draw through with a needle or sharp object after hardening. Soft ground – an etching ground usually with tallow or grease that is used chiefly to obtain textural lines and effects on the plate by pressing cloth or similar material into the ground or by drawing with a pencil on a piece of paper laid over it, and Aquatint – a method of etching a printing plate so that various tones similar to watercolor washes can be reproduced (Merriam Webster, n.d.).

In the Hard ground technique, Winsor screen filler no. 67 mixed with water was coated onto the surface and then scratched out only in the desired area. This allows Dichloromethane to dissolve the desirable space.

In the Soft ground technique, Poster color and Winsor screen filler no. 67 mixed with concentrated starch glue were used to coat the surface. Some areas of the ground would be stamped out, and some areas would be doodling out with any drawing tools and allowing Dichloromethane to dissolve the desirable opening areas on the plate.

In the Aquatint technique, Winsor screen filler no. 67 mixed with water was sprayed onto the surface thinly or thickly. This allows Dichloromethane to dissolve more or less of the desirable space between the screen filler's droplets on the plate.

## Experimentation and Results

### Drypoint Technique

In addition to using a needle and a soldier (Coulanges, n.d.), a 30-degree blade cutter can also be used to engrave the design effectively (figure 2). In Printmaking using the Drypoint method, the artist scratches an image onto a metal plate using a sharp instrument; the metal bits that stay attached to the surface are the burr. The burr then catches and holds extra ink during the process of printing, giving the image a soft and saturated appearance. Because the burr is made of tiny pieces of metal, the artist only can pull a relatively small number of prints that display the softness of the burr before it has worn away. (Coleman, 2017) Similarly, when working with an acrylic plate in this research, ten printing editions could be made and the degradation of tonal value from the worn burr could be observed starting from edition number 8th (figure 3). Along with this, an electric carving & marking pen can also provide acceptable quality prints in this category, as can be seen in figure 4.



Figure 2. Drypoint Processes.



Figure 3. Results of editions 1, 8, and 10 respectively.



Figure 4. An electric carving & marking pen (left), the plate (center) and printing results (right).

### Hardground Technique

The researcher slightly sanded the surface of the plate with 1000 grit sandpaper before coating to enable the screen filler to adhere to the surface more effectively. According to the experiments the most suitable proportion of a coating ground made from the mixture of screen filler and water was 3:2. Brushing off the residue caused by the dilution dissolving process by Dichloromethane (figure 5) could also improve the sharpness of the prints from the desired groves and lines from the process.



Figure 5. Scratching through the coating with a cutter (left); dichloromethane dripping (center); brushing off the residue (right).

Polishing the edge of the designated lines softly with 1000 grit sandpaper could further reduce the leftover residue from Dichloromethane dissolving as can be seen in figure 6. In this case, 33 editions were obtained.



Figure 6. Polishing softly with 1000 grit sandpaper around the design (left); the result of the first edition (center) and the 33rd edition (right).

For the doodling technique, Winson screen filler no.67 mixed with concentrated starch glue with the proportion of 1:3 was used as a soft ground to apply over the surface of the acrylic plate shown in figure 7. This substance was used as a replacement for the traditional soft waxy ground derived from the mixture of grease and/or asphaltum. (Merriam-Webster, n.d.)

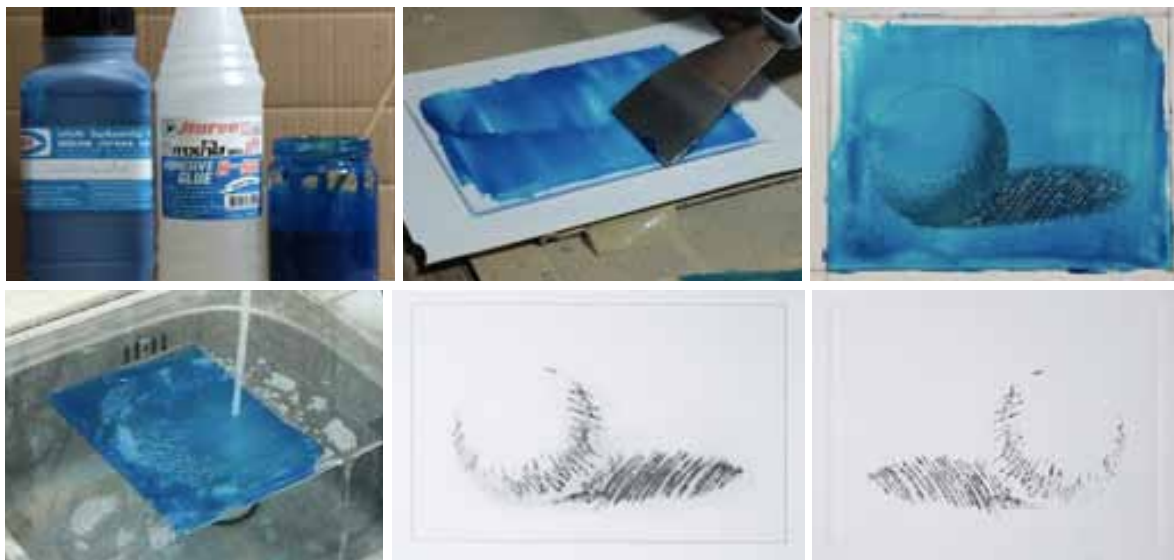


Figure 7. The mixture between Winson screen filler no.67 with concentrated starch glue for the doodling technique (top); the coating could be easily washed out by water (below left) the plate (below center); the resulting print (below right).

Another soft ground substance replacement for this research that the researcher tried out successfully was Poster Color, since one of its main ingredients is *Gum Arabic* (Kristin, 2018) which is also a good anti-solvent ground, for this matter. The result of applying the Poster Color on the plate for texture printing was favorable. The Dichloromethane partially permeates through the poster pigment and dissolves some part of the plate resulting in a similar tonal value to the Aquatint technique (figure 8). According to research conducted across several databases, Poster Color has never been the subject of an experiment. The plate from this technique can withstand the inking and printing process of up to 33 editions (figure 9).



Figure 8. The use of Poster Color as a coating substance for texture stamping.



Figure 9. The first edition (left) and 33rd edition (right).

### Aquatint Technique

In the first experiment, a random aquatint effect was achieved by dripping Dichloromethane directly onto the surface of the acrylic plate, and although the tonal value from printing looked soft and appealing, however, the intensity of the value of the outcome was uncontrollable (figure 10).



Figure 10. Tonal values achieved from aquatint technique deriving from direct dichloromethane dripping on the surface of the plate (right); the plate (center) the printing results (right).

As a result, more systematic dripping of Dichloromethane was added to the experiment. While the different numbers of drops added could provide various tonal values ranging from lighter to darker values. However, it appears that the tonal intensity increased with the number of drops and was only noticeable between 1-5 drops (figure 11). Increasing the number of drops of Dichloromethane after that produced no differences.



Figure 11. Tonal values deriving from direct dripping dichloromethane on an acrylic plate (left); After the first five drops, the intensity of the printing's result remained the same (right).

Since the direct application of Dichloromethane gave uncontrollable intensity of value, subsequently, the use of Dichloromethane resistant droplets of Winson screen filler no. 67 and water with the proportion of 30:100 ml. on the acrylic plate with spraying onto the acrylic plate was tried. The initial finding was that different quantities and sizes of droplets on the acrylic plate could give an impact on Dichloromethane dissolving levels resulting in different tonal values in print (figure 12).



Figure 12. The use of airbrush in Aquatint technique (left); Dichloromethane dripping (center left) the inked plate (center right); the printing results (right).

It is found that the use of hand spray and airbrush with a 30:100 ml mixture of Winson screen filler no.67 and water together with proper timing and techniques directly impacted the Aquatint tonal value achieved. Consequently, the finished plate carried out with the airbrushing tool yielded 32 editions. The quality of the tonal value of the prints started to decline from the 11th edition and was degraded from the 24th edition (figure 14).



Figure 13. The plate coated with the mixture of Winson Screen Filler no.67 and water (left); the coating could be easily washed out by water (right).





Figure 14. Printing plate made from an aquatint technique with airbrush (left); printing editions of 1st, 11th, 24th, and 32nd (respectively).

Using a hand spray tool (figure 15) that is more accessible at a more affordable price than an airbrush machine could also produce a favorable result. Although of all the 37 editions printed, the tonal value had slightly faded from the 13th edition and apparently, the fading became more obvious from the 18th edition. Eventually, on the 28th edition, the overall saturation of the printing became substantially decreased. It can be concluded that the acrylic plate usability for printing identical editions from this technique is between 10 to 13 editions (figure 16).

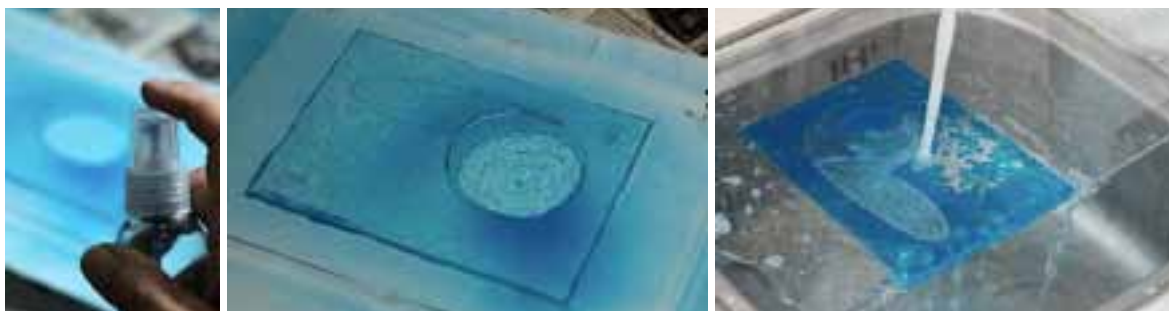


Figure 15. The use of a hand spray tool on the mixture of Winson Screen Filler no.67 and water (left); the coating was easily washed out by water (right).



Figure 16. Printing plate from a hand sprayed Aquatint (left); Printing results: the 1st, 13th, 18th, and 28th editions (respectively).

### Discussion

The 2 mm acrylic plate was the most suitable thickness for all the techniques experimented on within this research. As its physical condition remained intact despite Dichloro-methane dissolving. Additionally, its lightweight is also beneficial when handling within the operation procedure.

| General Attributes  |  |
|---|--|
| Acrylic Plate   | Copper Plate   |
| <ul style="list-style-type: none"> <li>● Lighter weight per square unit</li> </ul>  | <ul style="list-style-type: none"> <li>● Heavier weight per square unit</li> </ul>   |
| <ul style="list-style-type: none"> <li>● The price is ten times more affordable than that of a copper plate e.g., an acrylic sheet size of 122x244 cm. with 2 mm. thickness costs 1,337.50 THB (Approx. 32.5 USD) at the time of conducting this research.</li> </ul> | <ul style="list-style-type: none"> <li>● The price is ten times more expensive than that of an acrylic plate e.g., a copper plate size of 122x244 cm. with 1 mm. thickness costs 11,427.60 THB (Approx. 326.5 USD) at the time of conducting this research.</li> </ul> |
| <ul style="list-style-type: none"> <li>● Surface polishing is not needed as it was well-polished from the factory.</li> </ul>   | <ul style="list-style-type: none"> <li>● Before use, properly polishing the surface is needed, since scratches from the cutting to size process from the local vendor are commonplace.</li> </ul>  |
| <ul style="list-style-type: none"> <li>● The plate can simply be cut to size with a cutter or a hand saw.</li> </ul>  | <ul style="list-style-type: none"> <li>● More difficult to cut manually, cutting with a machine is preferable.</li> </ul>  |
| <ul style="list-style-type: none"> <li>● Easy to cut into any shape.</li> </ul>   | <ul style="list-style-type: none"> <li>● More effort is needed to cut into any shape.</li> </ul>   |
| <ul style="list-style-type: none"> <li>● Fewer editions can be made.</li> </ul>   | <ul style="list-style-type: none"> <li>● A larger number of editions and more delicate designs can be obtained.</li> </ul>   |
| <ul style="list-style-type: none"> <li>● Easy to store since the acrylic plate has no oxidation issue.</li> </ul>   | <ul style="list-style-type: none"> <li>● Likely to have an oxidation issue if not treated properly before storing.</li> </ul>  |

Figure 17. Table comparing the strength and weakness of using acrylic and copper plate for general printmaking.

### Drypoint Technique

It was more convenient to apply direct markings on an acrylic plate than on a copper plate as the surface is less rigid. Direct marking on an acrylic sheet through a Drypoint technique is more convenient since its material is less rigid. Thus, it is more comfortable to scratch with a tool. As a result, the artworks are better expressed in comparison to a copper plate and give a better feel when scratching with a tool which results in better expression of the artworks in comparison to the copper plate. However, the ink clinging along the Burr of the scratched lines was worn away more rapidly than those on the copper plate.

| Acrylic plate  | Copper plate   |
|--|--|
| <ul style="list-style-type: none"> <li>● Since the surface is less rigid, the Printmaker may find it more tactile to control the scratching tool.</li> </ul> | <ul style="list-style-type: none"> <li>● Since the surface is more rigid, the Printmaker may find it less tactile to control the scratching tool.</li> </ul> |
| <ul style="list-style-type: none"> <li>● The transparency of an acrylic sheet allows a printmaker to duplicate the design more easily.</li> </ul>            | <ul style="list-style-type: none"> <li>● The design duplication process is more complicated.</li> </ul>  |

Figure 18. Table comparing the strength and weakness of using acrylic and copper plate for Drypoint.

### Hard Ground Technique

The researcher experimented with a variety of grounds: Gum Arabic, gelatin, water-based adhesive, latex glue, screen emulsion, screen filler, etc. to resist Dichloromethane dissolving on the acrylic plate. Eventually, it was found that the mixture of Winson screen filler no.67 and water in the proportion of 3:2 gave an optimum result.

| Acrylic plate  | Copper plate   |
|--|--|
| <ul style="list-style-type: none"> <li>● Due to its elasticity, the sheets can return to their original form after being twisted without being damaged, and the weight per unit is lighter than the copper plate.</li> </ul> | <ul style="list-style-type: none"> <li>● It is difficult to return to their original forms after being twisted and the weight per unit is heavier than the acrylic plate.</li> </ul> |
| <ul style="list-style-type: none"> <li>● It is unnecessary to coat the back of the plate.</li> </ul>   | <ul style="list-style-type: none"> <li>● It is necessary to coat the back of the plate for further protection.</li> </ul>  |
| <ul style="list-style-type: none"> <li>● Screen filler coating is water-based.</li> </ul>  | <ul style="list-style-type: none"> <li>● Asphaltum coating is oil-based. Precautions must be taken.</li> </ul>   |
| <ul style="list-style-type: none"> <li>● A lesser amount of chemical is needed for the process; dichloromethane for instance.</li> </ul>   | <ul style="list-style-type: none"> <li>● Various concentrations of ferric chloride solution must be used along with tedious working processes.</li> </ul>                            |
| <ul style="list-style-type: none"> <li>● Less chemical substances and smaller working areas are needed.</li> </ul>   | <ul style="list-style-type: none"> <li>● Etching with ferric chloride needs a larger and specific working space.</li> </ul>  |
| <ul style="list-style-type: none"> <li>● Working safety and studio arrangement can be managed with ease.</li> </ul>  | <ul style="list-style-type: none"> <li>● Owing to the use of ferric chloride, several working safety procedures need to be applied.</li> </ul>                                       |

Figure 19. Table comparing acrylic plate Hard Ground technique findings to the traditional copper plates Hard Ground technique.

### Soft Ground Technique

With the mixture of Gum Arabic and color pigments in Poster Color used as a ground for this technique, it was possible for the Dichloromethane to partially infiltrate through the color pigment area and dissolve some part of the surface of the acrylic plate. As a result, it gave Aquatint-like tonal value, along with the imprinted traces on the acrylic plate. Furthermore, another finding was the use of a mixture of Winson screen filler no.67 and concentrated starch glue in the proportion of 1:3 ml for coating. It was found that the doodling lines could be expressed freely by drawing directly through the coating.

| Acrylic plate   | Copper plate  |
|---|---|
| <ul style="list-style-type: none"> <li>● Coating the back of the printing plate is unnecessary as soaking in an acidic solution is not needed.</li> </ul>                                     | <ul style="list-style-type: none"> <li>● Coating the back of the printing plate is necessary since soaking in an acidic solution is needed.</li> </ul>                        |
| <ul style="list-style-type: none"> <li>● The Poster color is widely accessible at an affordable price.</li> </ul>   | <ul style="list-style-type: none"> <li>● The soft ground solution must be prepared by printmakers or imported from abroad.</li> </ul>   |
| <ul style="list-style-type: none"> <li>● The poster color is water-soluble and can be used to coat the surface of the plate directly.</li> </ul>  | <ul style="list-style-type: none"> <li>● To make a Soft Ground solution, various ingredients are required, and proper procedures must be followed.</li> </ul>                 |
| <ul style="list-style-type: none"> <li>● With the use of Poster color coating, the imprinted design and desirable tonal value on the acrylic plate can be achieved simultaneously.</li> </ul> | <ul style="list-style-type: none"> <li>● With the traditional procedures, the imprinted design must be made on the plate before the Aquatint process.</li> </ul>              |
| <ul style="list-style-type: none"> <li>● The poster color is generally non-toxic.</li> </ul>  | <ul style="list-style-type: none"> <li>● The soft Ground solution can contain potentially harmful ingredients. And should be used with care and proper protection.</li> </ul> |

Figure 20. Table comparing acrylic plate Soft Ground technique findings to the traditional copper plates Soft Ground technique.

### Aquatint Technique

Dichloromethane was used as a solvent to dilute the acrylic plate surface, while several dilution-resistant grounds: Gum Arabic, gelatin, latex glue, water-based adhesive, screen emulsion, and screen filler, had been tried out as well. It was found that using hand spraying and airbrushing with the mixture of Winson screen filler no. 67 and water in the proportion of 30:100 ml, together with proper timing and techniques could provide proper aquatint tonal value for the printing.

| Acrylic plate  | Copper plate   |
|--|--|
| <ul style="list-style-type: none"> <li>● Coating the back of the printing plate is unnecessary as soaking in an acidic solution is not needed.</li> </ul>  | <ul style="list-style-type: none"> <li>● Coating the back of the printing plate is necessary since soaking in an acidic solution is needed.</li> </ul>   |
| <ul style="list-style-type: none"> <li>● Screen filler is water-soluble and can be cleaned easily.</li> </ul>  | <ul style="list-style-type: none"> <li>● The traditional acidic resistant ground on a copper plate is oil-based. Thus, several types of solvents are required.</li> </ul>  |
| <ul style="list-style-type: none"> <li>● The application of Dichloromethane in the process is direct and simple.</li> </ul>  | <ul style="list-style-type: none"> <li>● Various concentrations of ferric chloride solution must be applied, along with the tedious working processes.</li> </ul>  |
| <ul style="list-style-type: none"> <li>● Lesser chemical substances and smaller working areas are required.</li> </ul>   | <ul style="list-style-type: none"> <li>● Etching with Ferric Chloride requires proper preparation and specific working space.</li> </ul>   |
| <ul style="list-style-type: none"> <li>● Personal protection during the process is easier to manage.</li> </ul>  | <ul style="list-style-type: none"> <li>● Various amounts of Ferric Chloride solution together with larger working space are needed owing to the more tedious working process, resulting in more working safety concerns.</li> </ul>                        |
| <ul style="list-style-type: none"> <li>● Screen filler and Dichloromethane solutions are simple to use, and vendors are commonplaces.</li> </ul>   | <ul style="list-style-type: none"> <li>● Ferric Chloride solution is available from the specialized vendor and needs several preparation processes before use.</li> </ul>  |
| <ul style="list-style-type: none"> <li>● The mixture of Winson screen filler no. 67 and water is easy to use and water-soluble.</li> </ul>   | <ul style="list-style-type: none"> <li>● Asphaltum or Rosin widely used on copper plates as an acidic resistance ground are used with an oil-based solvent. Several coating and washing away with various solvents can be troublesome at times.</li> </ul> |
| <ul style="list-style-type: none"> <li>● Spray Coating of the mixture of Winson screen filler no. 67 with water is safe for use. However, protective masks, goggles, and safety measures are recommended.</li> </ul> | <ul style="list-style-type: none"> <li>● Most of the substances and chemicals used in the traditional Copper Plate Etching process are oil-based; thus, protective protocols are highly recommended for safety and health reasons.</li> </ul>              |
| <ul style="list-style-type: none"> <li>● Screen filler is generally non-toxic.</li> </ul>  | <ul style="list-style-type: none"> <li>● Various Ground solutions for Aquatint used in the traditional Copper Plate Etching process can contain potentially harmful ingredients.</li> </ul>  |

Figure 21. Table comparing acrylic plate Aquatint technique findings to the traditional copper plates Aquatint technique.

## Conclusion

It was found that the use of an acrylic plate with the alternative approach replacing the traditional copper plate Etching can be beneficial if the following strength and weakness are considered:

1. For the Drypoint technique, the use of a 30-degree blade cutter can provide a favorable result, but somehow a more ergonomic design of scratching tools can be developed in the future for more practical handling.
2. For the Hard Ground technique, the tools, and materials used along with the procedure are direct, simple, economical, and safer. Nonetheless, the adhesive strength of the mixture of the screen filler and water used to coat the plate should be improved to withstand a harder scratching action. Even though an economical number of chemical substances and a smaller workspace are needed, the precautions and safety measures shall not to be neglected.
3. For the Soft Ground technique, the discovery of the two benefits of Poster color delivering both imprinted images and Aquatint tonal value simultaneously on the same plate is advantageous. Somehow, if the surface of the acrylic plate can be further strengthened, then, it would be possible to generate finer details with favorable plate surface quality. As a result, it can be used to print a larger number of editions.
4. For the Aquatint technique, using hand spraying and airbrushing with the mixture of Winsor screen filler no.67 and water (30:100 ml) over the acrylic plate before the Dichloromethane dilution, provided desirable results. Yet, again, the adhesive strength of the mixture of the screen filler with water used to spray over the plate should be improved to withstand stronger dilution.
5. For all the techniques, somehow, if the solubility of Dichloromethane can be further developed to be stronger or weaker, variations of finer or coarser details of grooves and lines on the acrylic plate from the dilution would be more apparent.
6. Since only an economical amount of chemical was applied and a smaller working space is needed, this could be an alternative approach to a greener art process.

## Suggestions

1. Experiment with more alternative and safer chemical solutions, tools, and other materials to improve the quality of the process should be considered.
2. Further study of chemical reactions concerning alternative Intaglio Printmaking processes should be considered.
3. Collaboration with a chemical specialist is recommended.
4. Currently copper is recyclable whereas acrylic sheets, although can be reused for other purposes, are not that easy to be recycled (Chan, 2022). thus, proper disposal of the used acrylic plate or plastic should be considered (Wilai Asawadechsakdi and Yada Chavalkul, 2021).

5. Although it can be argued that nothing can be totally non-toxic (Graver, M., n.d.) but to the researcher direct experience in the field of printmaking, more researches and experiments for alternative (or safer) materials to be used has become widely practiced internationally, as for Thailand although the idea of Non-toxic printmaking is still relatively passive but the researcher hope that the finding in this research will encourage the lesser use of unhealthy chemical and shed light on further experimentation on this topic in Thailand.

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