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## Lusters and the slab form in raku

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LUSTERS AND THE SLAB FORM IN RAKU

Richard A. Hirsch

Candidate for the Master of Fine Arts  
in the College of Fine and Applied Arts  
of the Rochester Institute of Technology

1971

Advisor: Professor Hobart Cowles

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SLIDE LIST - RICHARD HIRSCH

1. Lusterd Plate	20 1/2" long
2. Gold Luster Plate	21" long
3. "Rainbow" Plate	18 1/2" long
4. Footed Bowl	10" high
5. Lustered Plate	18" long
6. Lustered Plate	19" long
7. Bowl	9 1/2" high
8. "Landscape" Plate	20 1/2" long
9. Lustered Bowl	10 1/2" high
10. Big Bowl	28 1/2" long 6" high
11. "Walking" Goblet	11" high
12. Luster Goblet	10" high
13. Spray Luster Goblet	12 1/2" high
14. Raku Goblet	10 1/2 high
15. Footed Goblet	12" high
16. "Mother of Pearl" Goblet	15" ht.
17. Gold Goblet	16" ht.
18. Gold Goblet	15" ht.
19. Crackle Bottle	10 1/2 ht.
20. Luster Bottle	8" ht. (Orange)
21. Precious Object Box	4x4x5"
22. Object Box	4x4x5"
23. Black Box	4x4x5"
24. Gold Precious Box	5x5x5"
25. Shell Box	6x5x5"
26. Gold Coil Box	14x4x3"
27. Gold Box with flocking	16 1/2" ht.
28. Raku Box	15 1/2" ht.

29. Covered Form	21 1/2" ht.
30. Covered Form	21" ht.
31. Covered Form	22" ht.
32. Covered Form	26" ht.
33. Covered Form	30" ht.

## INTRODUCTION

My thesis is not one that proves a point, nor professes to be a new break-through in ceramics. Basically, it is a report on my involvement with Raku at The School for American Craftsmen. A major goal was to attain practical and usable knowledge in this particular process. The purpose of the thesis was to correlate my investigations of lustered glazes with slab built forms using a Raku process. I decided to concentrate in one area, rather than dabble in many. Trial and error seemed to be the only way to begin to investigate and develop techniques. This approach fit my personality. Pride of accomplishment was a reward for long hours of testing. Failures were not depressing, because in them knowledge was acquired. Experimentation and inquiry led to experience and understanding. What the involvement actually accomplished was to give me a better understanding of pottery in general.

Throughout my entire learning experience at SAC Professor Hobart Cowles was primarily responsible for directing my insights and discoveries into the Raku process. More importantly, he offered me inspiration.

## REASONS FOR THE INVESTIGATION

When I came to the School for American Craftsmen my background was limited to some cone 9 reduction stoneware. During the first few weeks at SAC I continued with cone 9. A few glaze tests were run, but at the time I lacked enthusiasm. During the Rochester Clothesline Show and Sale I had seen a display of pottery which stimulated my interest. Strange colors made the work stand apart from all I had seen. The potter only mentioned that the glazes were metallic lusters obtained by a process known as Raku.

Included among the graduate students were Drew Krouse and John Frisenda. Both Krouse and Frisenda expressed a willingness to try Raku. What started out as a joint venture became an individual effort in self expression.

Achievement of aesthetic goals relied heavily upon technical considerations. During my investigation all elements of a Raku process were dealt with. Raku, like most other forms of pottery making, consists of three main components: the clay, the glaze, and the fire. Only after all these aspects of pottery are understood can a person give form to his ideas. Eventually aesthetic concerns dominated my thoughts after the technical phase had been comprehended. The use of metallic lusters on slab forms grew naturally out of my involvement with a Raku process.



## BACKGROUND

Before starting the experimentation, the many philosophies of Raku were examined. Associated with Raku is the Oriental Zen tradition of the tea ceremony.

"The tea masters, influenced by Zen Buddhist philosophy, took a unique pleasure in the conscious return to direct and primitive treatment of clay. "1.

In accord with this is the emphasis on beauty, the simple, and the natural.

"The cult of tea or Teatism, is a way of life that expresses an acceptance and veneration of the imperfect in an attempt to imbue man's commonplace surroundings with great meaning and beauty. It places great emphasis on meditation and quiet contemplation as a means of developing awareness of the inherent beauty of the non-perfect asymmetrical form. It celebrates the excitement of surface which derives its character from nature inspired phenomena, and it becomes a part of the spontaneous creative process transitory though it may be. "2.

Until the middle fifties Raku didn't receive much attention in this country. Recently American potters have made their own contribution in Raku quite different from the strict interpretation of Japanese potters. Describing the Raku pots shown in the Twenty-Third Ceramic National, a critic wrote "Nothing would amaze a Japanese potter more, however, than these Raku pots. Our style is home grown, and has little or nothing in common with the Raku pottery of Japan in spite of the name. "3.

<sup>1</sup>Bernard Leach, A Potter's Book, (3rd ed; Hollywood-by-the-Sea, Florida: Transatlantic Arts, 1967), p. 29.

<sup>2</sup>Hal Reigger, Raku: Art and Technique, (New York: Van Nostrand Reinhold Co., 1970), p. 9.

<sup>3</sup>Rose Slivka, "The Twenty-third Ceramic National," Craft Horizons (New York: American Craftsmen's Council, January-February, 1965), p. 21.



Daniel Rhodes feels "The original meaning of Raku has almost been forgotten. The more immediate response from the fire has speeded up the process of pottery making and brought a new excitement to it."<sup>4</sup> While I considered the ideals of the Japanese potters, the decision was made not to use Raku traditionally, but to seek my own forms, and experiment without the restrictions the Tea-Zen philosophy would impose. After some investigation and involvement, a personal concept would develop.

<sup>4</sup>Daniel Rhodes, Kilns: Design, Construction, and Operation, (Philadelphia: Chilton Book Co., 1969), p. 181.

## CHAPTER I

### TRIAL AND ERROR PERIOD

The investigation began simply by reading what a Raku process was. Charles Lakofsky describes it "as a Japanese technique involving the application of low firing, usually lead bearing glazes to porous, low biscuit fired pieces, and placing of the freshly glazed pieces directly into a pre-heated red hot kiln."<sup>5</sup>

Rhodes says that Raku is a procedure rather than a specific color or effect. "In making raku, the pottery is bisqued in the usual way, but in the glaze fire it is placed, after glazing, directly in the red hot kiln, then withdrawn and rapidly cooled as soon as the glaze has melted. In firing, one or two pots are placed in the kiln with tongs. The pots are observed through a spy hole and when the glazes are smooth and shiney, the pots are drawn out with the tongs. The glaze firing usually takes about ten minutes."<sup>6</sup>

Most sources researched felt that lead base glazes were the best to use because they melted smoothly and rapidly. Leach notes that all the glazes of the traditional Red Raku and Black Raku were lead based.

Armed with this knowledge it was decided to fire at once! A top loading-kiln was built out of soft firebrick. Burners were made from plumbing supplies, and propane gas was used as the fuel. Several lead based glazes were mixed and applied to the ware. After they were glazed, all were placed directly into the hot kiln and the gas pressure was turned up. What followed was a comedy of errors! From then on I knew that fundamentals were just as important in this process as in any other method or technique. Within one firing period the following was experienced:

<sup>5</sup>Charles Lakofsky, Pottery, Iowa: (W. M. Brown Co., 1968) p. 25.

<sup>6</sup>Daniel Rhodes, Clay and Glazes for the Potter, (Philadelphia Chilton Book Co., 1957) pp. 192-193.

1. Glaze exploded off the pot when placed in the red hot kiln.
2. Glaze melted and ran off the ware if slightly over-fired.
3. The glaze surface was pitted and scarred from the combustible material.
4. Some glazes were melted while others were still immature on the same piece.
5. The clay body cracked when placed in the hot kiln.

In addition to these technical difficulties there was no control over the smoking or reducing aspects of the process. Some pots were smoked black, while others received little smoke. In a few cases, half of the pot was reduced, while the other remained unaffected. The use of a top-loading kiln was dangerous and clumsy when unloading the hot ware with tongs.

There was no beginner's luck and the same awful results continued in other firings. For the first time in my short involvement with pottery, there was a desire and a need to do some technical experimentation. I began looking for the reasons that contribute to the failures.

The clay body first used was a regular cone 9 stoneware.

By volume:

Jordan	2
Cedar Heights Redart	1
North American Fire Clay	1
XX Sagger	1

Unfortunately, this clay body couldn't withstand the tremendous thermal shock. Raku clay formulas need sufficient non-clay material to lessen the contraction in the rapid heating and cooling cycles. Grog, flint, and fine sand added to the clay body keep the pores of the clay open and allow moisture to escape, preventing cracks and explosions. Usually a Raku body has about one-third non-plastic material added to a white clay recipe. To comply with these needs the following clay recipe was used.

North American Fire Clay	100
Cedar Heights Goldart	120
Tennessee #5 Ball Clay	60

Spodumene	20
Flint	20
Grog	80

The only problem was to find what temperature to biscuit fire. At first cone 04 was tried and the results were disastrous. Every piece put into the kiln exploded or cracked before the firing cycle was completed. Next it was biscuit fired at cone 08, and this temperature seemed satisfactory, in that, the body was porous enough, yet not too brittle.

Most disappointing was the poor result obtained from the lead base glazes. They produced some uninteresting browns, garish oranges, weak greens and blues, also a dull galena when heavily reduced. Some lead glazes that were tried:

<u>White</u>	
White lead	60
Flint	20
Frit 25	20
Tin Oxide	3

<u>Orange</u>	
White lead	60
Frit 25	40
Lead chromate	4

<u>Blue</u>	
Frit 529	70
Gerstley Borate	5
Flint	10
Soda Ash	10
Kaolin	5
Copper carbonate	3

<u>Black</u>	
White lead	60
Flint	20
Frit 529	20
Cobalt oxide	2.5
Red Iron oxide	4
Copper carbonate	2



Most of these lead glazes melted and ran off the ware even if slightly over fired. Color burnt out quickly in the short firing range. While lead glazes have a nice smooth surface, they remain soft and set up very slowly. This resulted in a poor surface quality when sawdust pitted and scarred the soft glaze surface. High lead glazes are easily reduced, yet a dirty metallic scum develops if over-reduced. Some luster was produced by these glazes, but because of the reasons stated and the fact that lead is extremely toxic, other kinds of low firing glazes were investigated.

I had acquired a list of alkaline glazes that Paul Soldner is reputed to use. I experimented with the following formulas.

<u>Basic</u>	
Gerstley Borate	50
Borax	50
<u>Runny Iron Yellow</u>	
Gerstley Borate	50
Borax	50
Iron	10
Rutile	3
<u>Yellow</u>	
Gerstley Borate	80
Burnt Umber	20
<u>Brown</u>	
Gerstley Borate	80
Yellow Ochre	20
<u>Glass Red</u>	
Gerstley Borate	50
Borax	50
Red Iron oxide	10
Copper carbonate	5

These glazes melted at a higher temperature than the lead bases. Their firing range was longer, and while they were fairly soft, less pitting and scarring occurred. Glass Red was most successful. When smoked, it produced a reddish copper; if left to air cool, it remained copper green.

Traditionally, the Japanese do not smoke or reduce their Raku ware outside of the kiln. However, in America it is the most important part of the process. It is the critical point, the "make or break" step in the entire process. Practical experience had no substitute and control was gained with time.

Combustible materials such as leaves, pine needles, sawdust, newspaper and straw, are used to create an atmosphere lacking in oxygen and containing free carbon. Pottery subjected to this atmosphere undergoes a chemical change. Clay, as well as glaze, is affected. Only on the surface does this change occur because of the short reducing time and low temperature. Reoxidation of the glazes will take place if the ware is taken out of this reducing atmosphere, while still hot enough to effect a chemical change.

Practically speaking, timing is most important. Surfaces which are the hottest will reduce the best. Pots should be removed from the hot kiln and placed in the reducing atmosphere immediately. When I talked to Paul Soldner at Geneseo last January 21, 1970, he said that "a good quick reduction is critical for the development of lusters". While getting the ware to the reducing atmosphere, a main concern is not to scar the glaze surface. Heavy reduction doesn't always depend on direct contact with the combustible material. Only a reducing atmosphere is necessary. Cooling should be done slowly and the pot should not be removed from the reducing chamber until a chemical change can no longer occur.

Contained in these few hurried minutes is the entire Zen philosophy of Raku. Reliance upon nature in the form of fire and smoke is the essence of Raku. During this dramatic period a "feel" for the captivating process develops. The romantic nature of the whole process is realized.

"What remains is a philosophy or a state of mind that for me places emphasis on the discovery of things not planned."<sup>7</sup>

<sup>7</sup>Lakofsky, Pottery. p. 37.

Four months had gone by and many individual techniques were developed. Ware was glazed days in advance to allow for complete drying. Kiln chambers were cooled down considerably before the next cycle of pots were introduced. Sometimes only one pot at a time was fired in order to get maximum results. Less and less combustible material was used in the smoking stage. Unexpected and accidental effects were taken into consideration and a certain control was obtained by practical experience and knowledge of the entire process.

Still, the development of metallic luster glazes had not yet been realized. Also, the forms were not in accord with the spontaneity of Raku. There was evidence of a need for more technical research and aesthetic considerations.



## CHAPTER II

### FURTHER TECHNICAL RESEARCH

Glaze effects in Raku are dependent upon many variable conditions, The process, by its own nature, has certain elements impossible to control. Most glazes never fire exactly the same, although some colors and effects can be controlled and repeated. However, because of the process, with its margin of so called "happenings", absolute duplication is impossible. Individual techniques result in different effects.

Up to this time, very few of the glazes experimented with produced the desired effects. Now, the formulation of my own glazes was necessary to produce the kind I wanted.

I first experimented with copper. A saturated amount was first believed to cause some glazes to develop a metallic luster. The copper was added to this base glaze which I acquired from Robert Jarvis, a graduate student at S. A. C.

#### Base C. M.

Frit P-25	43.6
Frit 3134	26.3
Lithium carbonate	9.9
Kaolin	10.2
Flint	14.0

Copper carbonate was added to the base in these percentages: 5%-25%.

Unfortunately, because there was so much copper, it reoxidized easily, thus producing a very dense green to greenish black. No metallic lusters were attained except where heavy reduction occurred. During the next series of tests, Red Copper oxide was used. This form of copper is already partially reduced, and although it mixes poorly with water and other chemicals, results were better. It seemed to luster more successfully.

At this time I realized the difference in results using two kinds of kilns. Using a gas kiln produced better lusters from copper than an electric kiln. In a gas kiln there is a slight reducing atmosphere in the firing stage. This

helps to develop the metallic luster even before it is removed from the kiln. Less Red Copper oxide in the glaze was needed to produce metallic lusters.

Inquiry was now made as to what other ceramic chemicals beside the copper oxides develop luster. Literature on metallic lusters revealed that lusters were a type of decoration used for centuries. Lusters were employed as a final decoration rather than as a complete glaze. Historically, the development of metallic lusters is credited to the Islamic potters. Persian ceramicists used luster as a purely decorative media. It was employed in a final firing over a transparent, alkaline glaze. These wares are reputed to be the culmination of the art of over-glaze luster. I saw a few examples in the Royal Ontario Museum in Toronto, and they are magnificent.

Describing this form of decoration, one source states that "Luster constitutes a form of decoration on ceramics and glass consisting of extremely thin films of metal which are deposited on the surface of the ware."<sup>8</sup> Hainbach classifies lusters as being either colored or colorless and their preparation by either the dry or wet method.<sup>9</sup> The most expensive of these lusters are what he calls "The Noble Metal Lusters".

For the preparation of these over-glaze lusters, a metallic salt is combined with pine resin and lavender oil. In this method during an oxidizing fire to red heat, carbon formed by the resin and oil reduces the metallic salt, which is deposited on the glaze surface.

<sup>8</sup>Kenneth Shaw, Ceramic Colors and Pottery Decorations (New York: Frederick A. Praeger., 1968), p. 80.

<sup>9</sup>Rudolf Hainbach, Pottery Decorating, (London: Scott Greenwood and Son., 1924), p. 202.

Preparation of these kinds of lusters entails complicated formulas and procedures. Expensive materials are used in the "noble metal lusters", such as gold and platinum. Lusters developed in these manners are now, unfortunately, associated with souvenir, ornamental ware and are used in banding common mass-produced dinnerware. Luster solutions of this type are sold commercially. Most are expensive and produce a flat luster. Developing lusters of this quality was not my intention. However, the use of the chemical compounds such as the metallic salts, were investigated and adapted to my Raku technique.

A partial list of metallic salts generally associated with over-glaze lusters was acquired.

#### Metallic Salts

1. Silver Nitrate
2. Bismuth Sub-nitrate
3. Gold Chloride
4. Ferric Chloride
5. Zinc Acetate
6. Tin Chloride

In addition to these metallic salts, other metallic compounds were tested. All the metallic colorants were added to the C. M. base, and then put through a Raku process including the smoking or reducing phase. They failed to develop any luster by themselves or in combination. Within the 1-10% range the following chemicals were added to the base.

1. Cobalt Carbonate
2. Cobalt oxide
3. Chromium oxide
4. Red Iron oxide
5. Iron Chromate
6. Nickel oxide
7. Manganese dioxide
8. Tungstic acid
9. Sodium uranate
10. Potassium dichromate

After testing those, a few metallic sulfates were tried with the same process.



Copper Sulfate  
Cobalt Sulfate  
Nickel Sulfate  
Manganese Sulfate

With the exception of Copper Sulfate, none of these developed any noticeable luster. Finally, I began to experiment with some of the metallic salts used in the over-glaze luster preparations. At this time a new base glaze was being tested and all the salts were added directly to it.

<u>C Base</u>	
Soda Ash	44.2
Frit W-15	30.9
Borax	18.6
Kaolin	24.0
Flint	65.0

All the tests were done with a Raku process including the reducing stage. Silver Nitrate was added to the C base in 1-2%. It produced an ivory to yellowish luster. Bismuth Sub-nitrate alone produced a pearly metallic luster. When combined with Silver Nitrate the results were quite satisfactory. A golden luster was developed with 1% Silver Nitrate and 1% Bismuth Sub-nitrate in the C base. At its best this glaze was yellowish gold in color along with a purple irridescence. Smoking provided color modulation and the Bismuth developed the over-all irridescence. (For awhile people in the shop called me "Beatrice" because of this glaze!) (See Slide 2)

Bismuth Sub-nitrate was also tried with Red Copper oxide. It imparted an irridescence to the copper luster and helped as a stabilizer to prevent the copper from reoxidizing. The result was a glaze that produced every metallic color imaginable from copper. (See Slides 1, 3, 6) These two glazes were my standard in the investigation.

<u>Base</u>	
Soda Ash	44.2
Frit W-15	30.9
Borax	18.6
Kaolin	24.0
Flint	65.0

<u>Gold Luster</u>	
1% Silver Nitrate	
1% Bismuth Sub-Nitrate	

<u>Copper Luster</u>	
2% Red Copper	
2% Bismuth Sub-Nitrate	

Along with these two luster glazes a vitreous englobe was developed.

Tennessee #5 Ball Clay	20
Flint	30
Frit 3191	25
Talc	10
Borax	7

<u>White</u>	
Opax	10

<u>Red</u>	
Red Copper	5%
Red Iron oxide	5%

# CHAPTER III

## CORRELATION OF LUSTERED GLAZES ON SLAB FORMS

Development of these luster glazes led me to seek forms that would display them. At first, shapes became test tiles for the new glazes. After some involvement the forms became as significant as the glazes.

Technical aspects of the Raku process also influenced the form. Ware made in a single piece had a better chance of surviving the glaze firing. Glazes reoxidized easily on large vertical forms. The major disadvantage of working with these types of forms was that they were hard to maneuver with tongs. Large, round shapes had an even greater tendency to roll off the tongs unless grabbed exactly in the middle. This was one of the reasons I tended to avoid large, round shapes. Size had only reasonable limitations, once the process was comprehended and facility with the tongs acquired.

Clay slabs were investigated to create forms not associated with those of stoneware. Slab forms related to the Raku process and hand-building lent themselves to many of the philosophies of Raku.

The investigation was an attempt to correlate the asymmetrical slab form with the excitement of surface, supplied by the metallic luster glazes and the Raku process.

Slab forms were developed in series. After most possibilities were exhausted, a new, related sequence was begun. Throughout, the tactile quality of clay and glaze was of primary importance to me. A surface quality was achieved by the juxtaposition of shiney metallic glazes and the dull mattness of the smoked clay body. Soft and malleable clay slabs could be rolled, bent, folded, squashed, pressed, impressed, and joined to create form and texture. With gentle urging and good timing the clay slab could

be shaped using its vitality to give the form a visual strength.

The procedure was to roll out clay slabs on either burlap or canvas. Each series used some kind of armature or basic form to support the wet clay. Molds were made from metal domes, biscuit pots, and plaster casts. Soft clay slabs were draped on or in the molds or wrapped around tubular shapes. Sometimes clay slabs were rolled inside cardboard boxes. Qualities inherent in the wet clay were guided and controlled. Organic and natural tendencies of soft clay slabs were utilized and encouraged because it was part of my philosophy of Raku. Forms were created by subtle direction and modification rather than force. I tended to work with fairly large forms in order for my work to be disassociated from the small scale of the traditional Japanese Raku.

Glaze was almost always applied by pouring or dipping. At first, the forms were entirely covered with glaze. Perhaps it was because I was so eager to display them all. Eventually, less and less glaze was used. The smoked clay body became an important "negative space". These areas were treated like negative space in painting and consideration of their final shape was important.

The large slab plates and bowls were solely dependent upon the interaction of glaze and bare clay. Large pools of raw glaze were poured into the platters, and gently rolled around. When fired, this produced large modulating color fields of metallic lusters. They were enhanced by the negative space of the unglazed clay body. (See Slides 1-6)

The goblet series was the best in the use of the slab as a soft malleable form. The luster glazes were used decoratively. Although the goblets had some thrown elements the treatment of the slab was important, and the same treatment proceeded to the next series of covered forms.

As the forms became more independent, glaze was used to describe them, rather than to dominate. With the large covered forms glaze was used to visually separate the top from the rest of the form. (See Slides 29-30)



Shiney glaze zones were employed to contrast with the blackness of the unglazed, smoked areas. (See Slides 31, 32) Detailed brushwork seemed unnecessary since the glazes by themselves were intricate enough.

Each kind of form required special smoking techniques. The intensity of smoke, along with the size and shape of the piece, were factors in developing certain methods.

Initially, pine needles and grasses were used. Occasionally, they produced some nice effects. However, sawdust was more readily available and it proved to be easier to control.

To prevent pitting and scarring from direct contact with sawdust on the glaze surface, the plates and bowls were turned over. Sawdust was thrown on the unglazed area. A large metal dome was then placed over the ware. It created a reducing atmosphere, contained the smoke, and prevented reoxidation.

With the goblets and small boxes, a little mound of shredded paper or sawdust was made. The red hot piece was placed in the center of the small heap. A short can or barrel was then placed over the ware to continue the reducing process.

Most difficult to smoke and control were the large covered forms. Smoke patterns broke up the verticality and destroyed the visual impact. A monochromatic tone in the unglazed areas was needed to describe the form. Best results were achieved when a clay sewer pipe was used. Sawdust was packed around the form after it was placed inside the pipe. This wedged the combustible material between the form and the inside of the pipe.

## SOME OBSERVATIONS

"Craftsmen of all times have battled with the material they have used, with the difficulties of the techniques, with the problems of form and expression. While in more primitive times the main difficulties lay in the technique, in our times of technical advancement the real problems lie almost wholly in form and expression."<sup>10</sup>.

Throughout my short experience with pottery, aesthetic concerns have always been important. Clay seems to be for me the best material for communication. "I consider clay to be just another art media. Each artist must be responsible for any ultimate value it may have."<sup>11</sup>.

With Raku there has been a complete interaction between the material, the fire and myself. Individuality, which we all seek, is inherent in the Raku process. Hand-building furthers the uniqueness of each piece. A feeling for each pot is acquired through the immediacy of the process. Due in part to this I have been interested and influenced by the idea of the object. Creating unique objects is not an original thought. Actually, today it is the trend. Many shows in the past few years have tried to restore to the object its intrinsic value and power. Shows such as "Objects U. S. A." and "Coffee, Tea and Other Cups" have influenced my ideas rather than any individual.

"The contemporary American Craftsman is less directly designing for function, the reality of machine made commodities, as he is obsessed by the nature of his materials and himself, and the degree to which he can reach object-ness."<sup>12</sup>.

<sup>10</sup> Marguerite Wildenhain, Pottery; Form and Expression, (New York: Reinhold Publishing Corp., 1962), p. 10.

<sup>11</sup> Paul Soldner, "Raku Invitational, "A Catalogue for an Exhibition; (Geneseo: 1970) p. 20.

<sup>12</sup> Rose Slivka, "The Object: Function, Craft, and Art," Craft Horizons (New York: American Craftsmen's Council, September-October 1965) pp. 10-11.

When my work is successful the objects have an intrinsic value, independent of their function. They take on a precious nature, in that a person using them becomes more aware of the function they serve, and more conscious of the objects themselves. In our throw-away society, it is nice to know some objects are irreplaceable, even by their maker.

"The Raku ware of the Zen tea masters still shows us into its spiritual orbit to this very day. The object truly made for itself has the power to renew itself in the energies, memories and actions of men."<sup>13</sup>

<sup>13</sup>Craft Horizons, (September-October 1965) pp. 10-11

## CHAPTER IV

### CONTINUED GLAZE RESEARCH

Work continued on glazes while slab forms developed. Other chemical compounds traditionally used in overglaze luster were researched and explored.

Gold Chloride, when used in complex luster preparations, produces a famous color called "Purple of Cassius". When added to my C base and fired in Raku, it yields some incredible and exotic colors. Three hundredths of a percent of gold chloride added to the base glaze produced shades of strawberry red with tinges of a purple opalescence. Unfortunately, gold, chloride, because of its expense, is impractical, except in limited experimentation. (They don't even stock it in the Chemistry lab! Nuts!!)

While testing ferric chloride and stannous chloride a new kind of technique was developed. Neither compound developed any noticeable luster when added directly to the C base. A second step was to mix a weak solution of the metallic salt with sawdust. When the hot piece hit the sawdust a light fuming took place. However, again no noticeable luster was achieved. Both compounds are mentioned in connection with fuming and irridizing glass.

"Glass surfaces, when heated and placed in contact with a metal salt in vapor form or in an atomized spray of the salt solution, a strongly adherent layer of an oxide of the metal is formed on the glass or ceramic surface. The thickness of the irridized film may be gauged by the apparent color of the light reflected from it. This succession of colors is analogous to the well known Newton rings."<sup>14</sup>.

<sup>14</sup>"Ceramic Raw Materials, " Ceramic Industry, January 1961, Chicago, Cahners Publishing Co.



My procedure was to glaze the ware and fire it up to temperature. Just before the glaze melted, a hot, saturated solution of the metallic salt was prepared. A fine spray was directed onto the pot immediately after it was pulled from the hot kiln. The spray gun was held about six inches from the piece. After spraying the pot, it was either air cooled or smoked in a sawdust barrel.

Glaze effects produced by this technique are difficult to describe without first defining the terms luster and iridescence.

Luster means "1. a glow of reflected light: gloss or sheen. 2. the appearance of the surface of a mineral as affected by or dependent upon peculiarities of its reflecting qualities."<sup>15</sup> Luster implies a shiney surface that may or may not be iridescent.

Iridescence implies a quality of surface that shows more than one color as in a prism. By definition iridescence is "a showing of many colors that are constantly changing."<sup>16</sup> An iridescent surface can be shiney, but not always. Another term often used for iridescence is "Mother of Pearl."

Aside from the differences in terminology, the results were desirable and the method exciting and rewarding. As yet, all the possibilities have not been reached. Experimentation will continue after this paper is written.

Spraying the soluble salts provided me with an element of control. Areas where luster or iridescence was desired received the spray. Sections not in contact with the spray remained unaffected. I could control the amount of luster or iridescence on a given surface. Both the glaze surface and the raw clay body were enhanced by certain solutions. Usually a light spray produced the best results. A heavy application was

<sup>15</sup>Webster's Third International Dictionary, 3rd ed. 1965

<sup>16</sup>Webster's New World Dictionary, elem. ed. 1961

really an overload of the metallic substance. The result was often a dry surface devoid of iridescence or luster. With the spray gun method maximum control could be attained. With fuming inside a kiln chamber, there was more of a chance factor. The possibility everything would get the irridizing or lustering vapor did not appeal to me because these effects would destroy, rather than enhance, the appearance of the ware. A great variety of glaze effects could be acquired by the use of different colorants in a base glaze along with different metallic salt sprays. Glazes of great depth were achieved by this technique.

Crackling the glaze created another variation. This was done after the red hot pot was sprayed with the metallic salt. It was placed in a sawdust barrel to smoke. Periodically the pot was removed from the barrel and moved about in the cool air. Sometimes a spray of cold water caused the glaze to crackle. Finally, the piece was left inside the smoking atmosphere to let the smoke develop in the glaze crackle.

Temperature is an important factor in the spray technique. Most chemicals tested did not work within the Raku heat range (1800°F and below). These compounds fused to the glaze surface but only produced white crystals.

Melting points of the metallic salts provide some clue as to whether they might work within the Raku temperature range. However, in some cases, less temperature was needed to produce desireable results. Particularly with stannous chloride, if the surface of the glaze was too hot, it just volatilized and left the glaze unaffected. Oddly enough, some chemicals that worked well alone were less successful when combined. The combination seemed to cancel out most identifying traits of each separate metallic salt.

Dr. Fred A. Elder, Assistant Professor of Chemistry, at the Rochester Institute of Technology, calls this deposit of metallic compound a "Thin film Phenomena".

Metallic solutions are either chemically or mechanically bonded to the surface of the glaze. A mechanical bond is caused by heat, whereas in a chemical bond, there is a reaction between an acid and a base. The metallic salt spray is the acid while the glaze is the base. Dr. Elder feels that most metallic salts would develop an iridescence if the film deposited was thin enough. He defines iridescence as "Interference Patterns of Light". Absolute control of the spray solution would be necessary to obtain a thin enough film in order for some chemical compounds to develop an iridescence. He related the idea of vacuum plating metals on a ceramic surface that was totally clean and smooth. \*Also he feels that different kiln atmospheres might produce distinctive changes in the effects of metallic salts. Atmospheres of nitrogen and argon have been suggested.

Within my investigation, the most successful of the metallic salts were in chloride form. The actual reason for this is somewhat of a mystery. Dr. Elder believes that hydrochloric acid produced by the chlorides is stronger than other acids such as nitric acid produced by the nitrates. Professor Cowles feels that hydrochloric acid from the metallic chloride etches the glaze surface when the spray hits the hot glaze surface, producing a chemical as well as a mechanical bond. With chlorides no oxygen is introduced to the glaze surface. Nitrates contain oxygen, and produce the metal in its oxide form when the spray solution is deposited on the glaze surface.

Inhalation of these compounds is extremely dangerous because of their toxicity. Care was taken when spraying and use of a strong ventilation system was necessary.

Using the methods described in the spray technique, these chemicals did not work within the Raku temperature range or atmospheric conditions:

1. Cobalt Chloride
2. Nickel Chloride



3. Manganese Chloride
4. Barium Chloride
5. Zinc Nitrate
6. Ferric Nitrate
7. Aluminum Nitrate
8. Chromium Nitrate
9. Barium Nitrate
10. Strontium Nitrate
11. Antimony Tri-chloride
12. Molybolic Acid
13. Tungstic Acid
14. Potassium Chrom Alum
15. Cobalt Sulfate
16. Nickel Sulfate
17. Antimony Nitrate
18. Cadmium Nitrate

The following compounds have worked within the Raku heat range and atmospheric conditions using the spray technique:

1. Tin Chloride
2. Zinc Acetate
3. Ferric Chloride
4. Zinc Chloride
5. Cuprous Chloride
6. Cupric Acetate
7. Cupric Nitrate

Tin Chloride gave a glossy irridescence. Over a white base glaze it produced a handsome "Mother of Pearl", extremely rich in depth and variation. The glaze used with Tin Chloride melted at a lower temperature, thus preventing the tin from completely volatilizing.

<u>P. White Glaze</u>	
Frit P-25	36
Frit 3124	28
Kaolin	8
Flint	12
Lithium Carbonate	8
Opax	10

Zinc Acetate produced an irridescent, rainbow effect and was used over blue and green glazes. The main difference between Zinc Acetate and Tin

Chloride was that the zinc produced a mat surface, while the tin was very glossy.

Ferric Chloride was the only compound tested that produced both an irridescence and a luster. The luster color range was yellow orange to reddish brown. (See Slide 20) Ferric Chloride produced an extremely glossy surface, which in some cases destroyed the color of the glaze beneath. Sometimes it completely obscured the base glaze as in the case with this glaze:

Red Glaze

Ceramic Color and Chemical Mfg. Co., Inc. Special Frit 441	100
Ceramic Color and Chemical Mfg. Co., Inc. Red Stain 3352	7

If Ferric Chloride was sprayed on thickly there was a noticeable build-up of iron. This thin deposit was brown in color and devoid of any luster or irridescence. Best results were gotten when Ferric Chloride was used over the clear and the yellow base glaze.

Clear Base

Soda Ash	74
Frit W-15	310
Kaolin	38
Flint	144

Yellow

Potassium Bi-chromate	1/2-1%
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Using the yellow glaze underneath the Ferric Chloride spray, the color range was yellow to red orange. Both had luster and irridescence.

Along with these metallic compounds some soluble salts of copper were tested. Actually, the spray just deposited the metal substance on the glaze surface. If left to air cool, the copper would stay a familiar green. Reduction was necessary to produce a metallic luster. A copper yellow was achieved by the spray method.

## APPENDIX

### Melting Points of some chemical compounds

Chemical	Melting Temperature	Boiling Point
Antimony Chloride $\text{SbCl}_3$	73.4°C	220.2°
Barium Chloride	925°	1560°
Bismuth Sub-Nitrate	260°	-
Cadmium Chloride	568°	960°
Cobalt Chloride	-	-
Cupric Chloride	498°	-
Cuprous Chloride	422°	1366°
Cupric Nitrate	114.5°	-
Ferric Chloride	282°	315°
Manganese Chloride	650°	1190°
Molybdenum Chloride	-	-
Nickel Chloride	-	973°
Platinum Chloride	581°	-
Selenium Chloride	-	288°
Silver Nitrate	212°	444°
Silver Chloride	455°	1550°
Stannous Chloride	246.8°	623°
Tungstic Acid	1473°	-

## CONCLUSION

I have heard Raku described as being quick and flamboyant. Many believe it is a fad soon to vanish from the American ceramic scene. Others feel it is a valid use of ceramic materials. Some say Raku depends too much on luck. While I will admit there is a certain amount of luck involved, I submit that this is true in many ceramic processes on the studio level.

"In every culture, we may be sure, divine power has been invoked for the success of the firing, and kiln gods, prayer sticks, and offerings have been common. Placing one's pieces in the kiln is a kind of surrender, a giving up to the metamorphic forces of the fire."<sup>17</sup> "The greatest pots are those one meets coming from the kiln as strange objects; they may seem, in texture and color, quite beyond one's power to visualize or predict."<sup>18</sup>

Inevitably, in America, the term Raku will fade into the background. Hopefully this pottery will be given merit for what it looks like rather than slighted for how it is made.

For the past two years I have worked almost exclusively incorporating luster glazes on slab forms. Many techniques were developed using a Raku process. My enthusiasm for the process is still undiminished and further exploration will continue.

"Raku, which was originally an aspect of a Zen-inspired tea cult, has become a vehicle for the sudden thrust of intuition and the playing of hunches: the power of Zen still at work, perhaps."<sup>19</sup>

With Raku I have been able to understand more intimately the power of fire as it transforms clay and raw chemicals into ceramic objects.

<sup>17</sup>Rhodes, Kilns, pp. 189-190

<sup>18</sup>Ibid

<sup>19</sup>Ibid, p. 181



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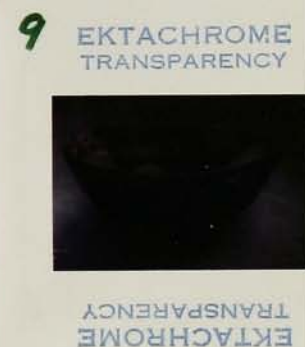
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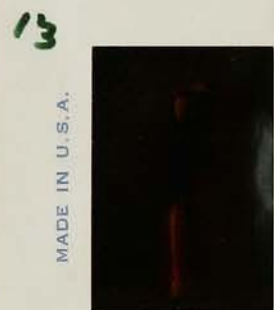
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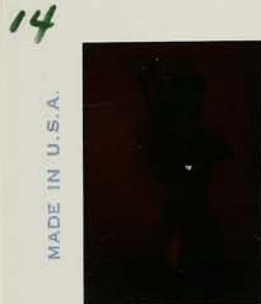
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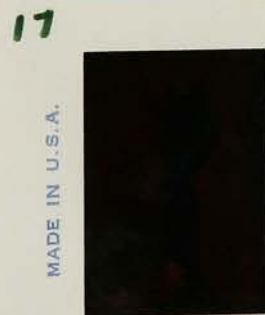
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