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A NEW PERSPECTIVE ON CHINESE RED GLAZE

ÇİN KIRMIZISI SIRLARA YENİ BİR BAKIŞ AÇISI

Berk ERGÜL
Hasan BAŞKIRKAN

ORCID: B.E. 0000-0003-3159-1846
H.B. 000-0001-6052-8518

Corresponding author/Sorumlu yazar:
[1] Berk Ergül
Mimar Sinan University, Türkiye
E-mail/E-posta: berk_ergul@hotmail.com

[2] Hasan Başkırkan
E-mail/E-posta:
hasan.baskirkan@msgsu.edu.tr

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Abstract

Glazes obtained by the reduction method, also called Chinese red or copper red in the literature, were first seen on porcelains of the Tang Dynasty (618-907) and Northern Song Dynasty (960-1126) periods in China. These glazes, which require a very difficult process to produce, are obtained by reducing the copper compounds in the recipe in the kiln. From its historical process to the present day, the surface of Chinese red glazes has been desired to be shiny and smooth, and their production has been carried out according to this principle. Within the scope of this study, it was aimed to bring a new artistic perspective to Chinese red glazes and instead of a smooth surface appearance, it was aimed to obtain a pinhole image known as a glaze defect. For this purpose, silicon carbide (SiC) was used to achieve the desired effect. Under normal conditions, the reduction process is carried out when the kiln cools down after neutral firing. However, it aims to give a different perspective to the traditional Chinese red glazes obtained by reduction by developing an alternative firing method caused by impossibility. To contribute to the language of discourse in art ceramics, a new proposal is presented with the interpretation of Chinese red glazes.

Keywords: Glaze, Chinese Red, Silicon Carbide, Copper Compounds, Reduction.

Öz

Çin kırmızısı veya literatürde bakır kırmızısı olarak da adlandırılan, indirgeme yöntemiyle elde edilen sırlar, ilk olarak Çin'de Tang Hanedanlığı (618-907) ve Kuzey Song Hanedanlığı (960-1126) dönemleri porselenleri üzerinde görülmüştür. Üretimi oldukça zorlu bir süreç gerektiren bu sırlar, reçetesinde bulunan bakır bileşiklerinin fırında indirgenmesiyle elde edilmektedir. Tarihsel sürecinden günümüze kadar, Çin kırmızısı sırların yüzeyinin parlak ve pürüzsüz olması istenmiş, bu prensibe göre üretimleri gerçekleştirilmiştir. Bu çalışma kapsamında Çin kırmızısı sırlara yeni bir sanatsal bakış açısı getirilmek istenmiş ve pürüzsüz yüzey görünümü yerine bir sır hatası olarak bilinen iğne deliği (pin hole) görüntüsünün elde edilmesi amaçlanmıştır. Bu amaçla istenilen etkiyi elde etmek için silisyum karbür (SiC) kullanılmıştır. Normal şartlarda nötr pişirimin ardından fırın soğumaya geçtiğinde indirgeme işlemi gerçekleştirilmektedir. Fakat indirgemeyle elde edilen geleneksel Çin kırmızısı sırlarına imkansızlığın doğurduğu alternatif fırınlama yöntemi geliştirilerek farklı bir bakış açısının kazandırılması hedeflenmiştir. Sanat seramiğinde söylem diline bir katkı sağlayabilmek amacıyla Çin kırmızısı sırlara getirilen yorumla yeni bir öneri sunulmuştur.

Anahtar Kelimeler: Sır, Çin Kırmızısı, Silisyum Karbür, Bakır Bileşikleri, İndirgeme.

INTRODUCTION

Chinese red glazes, or copper-red glazes as they are also called in the literature, are first known from porcelain examples made in the village of Cahangsha in Hunan province during the Tang Dynasty (618-907) and Northern Song Dynasty (960-1126) in China. Named after China, the geographical region where it is found, these glazes have names such as oxblood, sang de boeuf, flambé, and peach bloom depending on their appearance (Başkırkan & Arcasoy, 2020). Chinese red glazes have been important for ceramic art since the Tang and Northern Song Dynasties. Traditionally, these glazes were made by reducing copper compounds to produce bright, smooth, and red surfaces. However, in contemporary ceramic art, more innovative interpretations are needed for artists seeking not only flawless surfaces but also textured and organic surface effects.

Although Chinese red glazes are characterized by their glossy, smooth, and red surfaces, today's contemporary ceramic art requires more innovative interpretations for artists seeking not only flawless surfaces but also textured and organic surface effects.

This study aims to bring a new perspective to traditional Chinese red glazes and to evaluate glaze defects such as pinholes on ceramic surfaces as an aesthetic element. Using silicon carbide (SiC), these imperfections were deliberately created, and an alternative firing method was developed. This innovative approach offers new aesthetic and creative possibilities in contemporary ceramic art, aiming to bring together both historical and modern elements in ceramic art.

HISTORY OF CHINESE RED GLAZES

The use of the color copper red dates to the Eighteenth Dynasty in Egypt (ca. 1500 BC), according to Robert Brill. The appearance of the copper red color is associated with the processing of copper metal and the beginning of glass production during this period. The opaque red glass produced in Egypt at the time contained 5-10-15% copper oxide (Brill, 1970; Tichane, 1998).

The first copper-red glaze samples were obtained by the accidental use of reductive firing. Although these samples were red, they were not very successful. Trace amounts (2-3%) of copper oxide were used in the glazes of the period and this amount was insufficient for the formation of the copper red color (Tichane, 1998, p. 5). In the Far East, copper-red glazes are known from porcelain examples made in Changsha village in Hunan province during the late Tang Dynasty (618-907) and Northern Song Dynasty (960-1126) in China. (Wood, 2000, p. 169). The famous Chun (Jun) glazes of the Northern Song Dynasty often had red-purple-blue stains due to their high copper content (
Figure ***1***).

Some of the copper red splashes on early Chun ware are magnificent, but the colors grade off into plum, purple, and blue too. Furthermore, where the copper content has become too high, they also form blacks and greens, when the high concentration of copper is oxidized during the cooling process

Figure 1. Jun ware jar, Song through Yuan Dynasties (960–1368) (Unm.edu, n.d.).

During the reign of Hsuan-Te (Xuande), the fourth emperor of the Ming Dynasty (1426-1435 AD), copper-red glazes covered the entire surface of ceramics, unlike in previous periods. This period is also considered to be the time when the most successful examples of copper-red glazes emerged (Figure 2). Studies at the Shanghai Institute of Ceramics have shown that the glaze composition used in this period was simple, but the firing process was quite complex. The red glaze has a copper oxide content of 0.5-1% compared to the transparent glaze content in blue and white decorated works. (Vaikner, 1997, p. 187). From the end of the 15th century until the reign of Kangxi, the fourth emperor of the Qing Dynasty (1662-1722), a great effort was made in Jingdezhen to develop copper-red glazes, including peach bloom, flambé, and langyao (Tichane, 1998, p. 6).

Figure 2. Copper red dish with Xuande (1426-1435) mark, Ming Dynasty (1368–1644), The Metropolitan Museum of Art (Metmuseum, n.d.).

In today's contemporary ceramics art, many artists develop traditional Chinese red glazes by adding their interpretations and using them in their works. For example; Tom Turner has developed a technique called “Chemical Reduction” in which he obtains Chinese red glazes through the reactions of chemicals added to the glaze recipe without the need for a reducing environment during firing (

Figure **3**) (Turner, 2012, p. 96).

Figure 3. Chemically Reduction Oxblood, Tom Turner, 2014 (Facebook, n.d.).

Artist John Eagle uses Chinese red glazes, a type of glaze that is difficult to control, in a controlled and conscious way. For more than 40 years, the artist has been working with Chinese red glazes and has made them his signature, consciously using the glaze layer by layer to create various landscape images on the surfaces of his forms (Figure 4) (Eagle, n.d.).

Figure 4. Inspired by Landscape, John Eagle, 2023 (John Eagle Ceramics, n.d.).

The artist Greg Daly is particularly famous for his use of glaze techniques. He conducted research on Chinese red glazes in 1999 and has published extensively on special effect glazes. Inspired by nature and landscapes, he often uses Chinese red glazes and luster glazes in his work (Figure 5) (Daly, n.d.). Apart from Greg Daly, John Britt, Nigel Wood, and Robert Tichane have also published on Chinese red glazes.

Figure 5. Copper Red Vase, Greg Daly (Marianwilliamspottery, n.d.).

THE MAKING OF CHINESE RED GLAZES

Chinese red glazes are formed by the reduction of copper oxide (CuO), a coloring oxide. This oxide, which gives green and blue tones in oxidizing or neutral firings, gives red and red tones with the reduction of oxygen in the kiln.

The amount of copper oxide used in Chinese red glazes is quite low (0.3-1.0%), but strong and saturated red tones can still be obtained. As the amount of copper oxide used increases, the red color begins to lighten and turn green. In addition, the use of tin oxide (SnO_2) in the content of Chinese red glazes not only causes the formation of blue colors in the glaze but also strengthens the red color, resulting in reds called flambé, which also contain blue-green-purple color transitions on the surface (Özalp, 2011; Sevim, 2006).

Reductive firing is required for the formation of Chinese red glazes. Reductive firing is the reduction of high-value oxides to low-value by the reduction of oxygen in the firing environment. The reduction process is carried out by adding combustible materials such as sugar, naphthalene, burnt oil, kindling, and sawdust into the kiln during firing. In Chinese red glazes, the reduction process is usually carried out between 800-700°C after the kiln cools down. During reduction, the red color is formed as a result of the transformation of copper oxide into copper oxide and the colloidal dispersion of copper (Başkırkan & Arcasoy, 2020). In addition, tin (II) oxide (SnO) and iron (II) oxide (FeO) to be used in the glaze content increase the reduction potential, convert copper(I) oxide into metallic copper, and increase the brightness of the red color (Balyemez & Başkırkan, 2021).

EXPERIMENTAL STUDIES

This study aims to bring a new perspective to the use of Chinese red glazes in contemporary ceramic art by deliberately applying pinhole, a glaze defect, on Chinese red glazes known for their shiny and smooth surface.

Pinhole is a ceramic glaze defect that is commonly seen in ceramic glazes and is caused by the bursting of air bubbles on the glaze surface during firing. These air bubbles are formed during the removal of organic matter from the glaze and mud by burning. As the temperature rises during firing, the air bubbles grow and rise to the surface of the molten glaze. When the bubbles reaching the surface burst, small holes called pinholes are formed (Figure 6). The size and density of pinholes generally depend on the firing time and the thickness of the glaze applied. If the glaze is kept long enough, the bubbles can be filled by the glaze, thus preventing the formation of pinholes. However, if the holding time is insufficient, cooling starts before the bubbles are filled and the pinhole problem arises. In the case of thick glaze applications, larger air bubbles are formed and as a result, larger pinholes are observed (Fraser, 2005, p. 132-135).

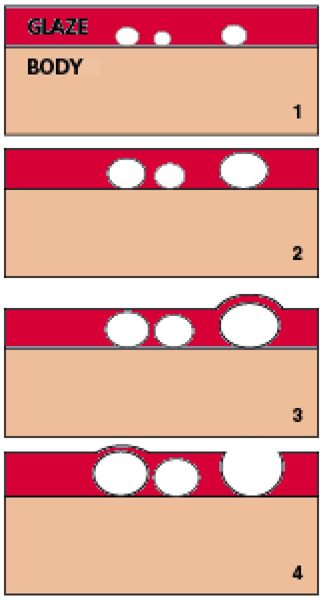

Figure 6. Pinhole formation stages (Ceramic Arts Network, n.d.).

In the personal applications, three different flambé glaze recipes were created to obtain flambé effective glazes and a total of nine different variations were obtained by making various changes in the content and ratios in these recipes. Since the pinhole effect wanted to be applied consciously and its effect wanted to be increased in the recipes created, silicon carbide (SiC) was added to the recipes to ensure this.
Silicon carbide is a compound that creates a local reduction when used at a rate of %0,2-2 in Chinese red and celadon glazes and provides a foaming and crater effect in the glaze as its rate increases in the recipe (Bloomfield, 2020). The intensity of this effect becomes more pronounced as the amount of silicon carbide added to the recipe increases. When glazes containing silicon carbide enter the melting process, the element silicon (Si) combines with oxygen (O_2) in the kiln atmosphere to form silicon dioxide (SiO_2). Following this reaction, carbon (C) reacts with oxygen to produce carbon dioxide (CO_2). The pressure created by the gases resulting from these reactions causes air bubbles to form under the glaze layer. These bubbles create pressure as they move toward the surface, causing bubbling and crater-like holes to form on the glaze surface (Avinal, 2024, p. 690).

As mentioned before, the reduction process in Chinese red glazes is normally carried out during the cooling phase of the kiln. Still, since the kiln used in this study was not suitable for this method since it was desired to make stoneware glaze at a high temperature within the scope of this study, the prepared glazes were glaze fired at 1200°C in a neutral atmosphere. The glaze-fired forms were then fired again in the enamel kiln in a reducing atmosphere (Figure 7).

Figure 7. a) Glazed forms before firing. b) Placement in the enamel kiln after glaze firing.

The glaze-fired forms were placed in the enamel kiln and the kiln was heated to 1000°C. After waiting for a while at this temperature, the kiln was allowed to cool down slowly. After the kiln was cooled down to 800°C, sugar-filled ceramic pots were placed in the kiln for reduction, and reduction was carried out in the kiln (Figure 8). The reduction process was repeated 6 times in total (Figure 9).

Figure 8. Placing the ceramic pots in the kiln.

Figure 9. Reduction process.

After the reduction process was repeated 6 times, the kiln door was closed and allowed to cool slowly. The results of the neutral firing and reduction process are presented in Table ***1***. with the recipes used.

Table 1. Recipes and test results.

Neutral Firing	**No.1**		**Reductive Firing**
	Sodium Feldspar	40	
	Quartz	26	
	FerroFrit 3289	14,50	
	Whiting	14	
	Zinc Oxide	3	
	Kaolin	2,50	
	+	**100**	
	Bentonite	3	
	Red Iron Oxide	1	
	Silicon Carbide	1	
	Tin Oxide	1	
	Copper Carbonate	0,40	
Neutral Firing	**No.2**		**Reductive Firing**
	Quartz	35	
	Potash Feldspar	25	
	Kaolin	12	
	FerroFrit 3289	12	
	Dolomite	8	
	Whiting	8	
	+	**100**	
	Red Iron Oxide	1	
	Tin Oxide	1	
	Copper Carbonate	0,40	
Neutral Firing	**No.3**		**Reductive Firing**
	Barium Carbonate	4,04	
	Sodium Feldspar	4,62	
	Magnesium Carbonate	4,04	
	Whiting	14,43	
	FerroFrit 3289	1,01	
	Potash Feldspar	41,56	
	Kaolin	4,33	
	Quartz	25,97	
	+	**100**	
	Tin Oxide	0,87	
	Zinc Oxide	1,73	
	Copper Carbonate	0,40	
	Bentonite	1,01	

Neutral Firing	**No.4**		**Reductive Firing**
	Sodium Feldspar	54,50	
	Quartz	26	
	Whiting	14	
	Zinc Oxide	3	
	Kaolin	2,50	
	+	**100**	
	Bentonite	3	
	Red Iron Oxide	1	
	Silicon Carbide	1	
	Tin Oxide	1	
	Copper Oxide	1	
Neutral Firing	**No.5**		**Reductive Firing**
	Quartz	35	
	Potash Feldspar	37	
	Kaolin	12	
	Dolomite	8	
	Whiting	8	
	+	**100**	
	Red Iron Oxide	1	
	Tin Oxide	1	
	Copper Oxide	1	
Neutral Firing	**No.6**		**Reductive Firing**
	Barium Carbonate	4.04	
	Sodium Feldspar	5,63	
	Magnesium Carbonate	4,04	
	Whiting	14,03	
	Potash Feldspar	41,56	
	Kaolin	4,33	
	Quartz	25,97	
	+	**100**	
	Tin Oxide	0,87	
	Zinc Oxide	1,73	
	Copper Oxide	1	
	Bentonite	1,01	
Neutral Firing	**No.7**		**Reductive Firing**
	Sodium Feldspar	40	
	Quartz	26	
	TF-11 Lead Frit	14,50	
	Whiting	14	
	Zinc Oxide	3	
	Kaolin	2,50	
	+	**100**	
	Bentonite	3	
	Red Iron Oxide	1	
	Silicon Carbide	1	
	Tin Oxide	1	
	Copper Carbonate	1	
Neutral Firing	**No.8**		**Reductive Firing**
	Quartz	35	
	Potash Feldspar	25	
	Kaolin	12	
	TF-11 Lead Frit	12	
	Dolomite	8	
	Whiting	8	
	+	**100**	
	Red Iron Oxide	1	
	Tin Oxide	1	
	Copper Carbonate	1	

Neutral Firing	**No.9**		**Reductive Firing**
	Barium Carbonate	4,04	
	Sodium Feldspar	4,62	
	Magnesium Carbonate	4,04	
	Whiting	14,43	
	TF-11 Lead Frit	1,01	
	Potash Feldspar	41,56	
	Kaolin	4,33	
	Quartz	25,97	
	+	**100**	
	Tin Oxide	0,87	
	Zinc Oxide	1,73	
	Copper Carbonate	1	
	Bentonite	1,01	

As a result of the tests, the silicon carbide in the recipe content was first increased up to %5 to improve the pinhole effect and copper color obtained in the glaze recipe No.7 (Table 2). Then, the proportion of copper carbonate compound in the recipe content was kept constant and copper oxide was used instead and the silicon carbide content was increased up to %5 (Table 3).

Table 2. Tests with copper carbonate.

Silicon Carbide	**%2**	**%3**	**%4**	**%5**
Neutral Firing				
Reductive Firing				

Table 3. Tests with copper oxide

Silicon Carbide	**%2**	**%3**	**%4**	**%5**
Neutral Firing				

Reductive Firing				

Stoneware clay was used in the tests. In order to add richness to the study and to observe the reactions of the glaze as a result of interaction with different clay bodies, tests were carried out on forms shaped with red stoneware clay and porcelain clay by applying glaze code No.7 (Table 4).

Table 4. Results on different clay bodies.

	Red Stoneware Clay	**Porcelain Clay**
Neutral Firing		
Reductive Firing		

Within the scope of the study, experiments were carried out by adding silicon carbide to oxblood glaze recipes prepared with two different frits to observe the effect of silicon carbide use on other Chinese red glazes besides the Chinese red glazes called flambê (Table 5).

Table 5. Oxblood tests with silicon carbide additives.

Neutral Firing	**Oxblood Recipe F277**		**Reductive Firing**
	Potash Feldspar	62	
	F277 Frit	22	
	Whiting	10	
	Kaolin	4	
	Quartz	2	
	+	**100**	
	Copper Carbonate	2	
	Tin Oxide	1	
	Bentonite	2	
	Silicon Carbide	1	
Neutral Firing	**Oxblood Recipe TF11**		**Reductive Firing**
	Potash Feldspar	62	
	TF-11 Lead Frit	22	
	Whiting	10	
	Kaolin	4	
	Quartz	2	
	+	**100**	
	Copper Carbonate	2	
	Tin Oxide	1	
	Bentonit	2	
	Silicon Carbide	1	

As a result of the tests, it was concluded that glaze recipe No.7 successfully achieved the desired effect. To observe the effect of the Chinese red glaze with pinhole appearance on large surface forms, three-dimensional artistic forms were designed, and glaze application was realized (Figure 10). The glaze was applied and fired by adhering to the process followed in the experiments (Figure 11).

Figure 10. Artistic form applications.

Figure 11. Artistic form applications pinhole and copper effect details.

CONCLUSION

In this article, the types of Chinese red glazes and the variables affecting the formation of these glazes are discussed. Traditional Chinese red glazes are characterized by their glossy and flawless surface. Due to the changing aesthetic orientations in contemporary ceramic art, an artistic approach was brought to these glazes, and it was aimed to create the pinhole effect, which is considered a defect in ceramic glazes, silicon carbide was added to the glaze recipes for this purpose.

As a result of the experiments, Chinese red glaze was obtained in all recipes. In the recipes coded No.1, and No.2, the glaze shows a matte feature, but the desired flambé effects are also seen. In recipe No.3, a clear and bright red glaze very close to the glazes characterized as oxblood was obtained. In these recipes, copper carbonate was preferred instead of copper oxide.

In the second group of recipes (No.4, No.5, No.6), the ratios of the coloring oxides were equal to %1 and the ratio of the raw materials was again equal to %100 by removing the frit from the recipes. Copper oxide was used as a colorant instead of copper carbonate. The results obtained in the trials in this group are reds with more semi-matte properties and closer to burgundy. In glaze No.4, pinhole effects were observed due to the silicon carbide content. Flambé effects were again observed in the No.6 glaze.

In the third and last group of recipes (No.7, No.8, No.9), TF-11 leaded frit was added instead of FerroFrit 3289. Coloring oxides were again equal to %1 and copper carbonate was used again as colorant. In the experiment coded No.7, it was observed that the pinhole effect seen in the previous group increased considerably. Unlike Chinese red, the interaction of silicon carbide and leaded frit resulted in the formation of very dense bubbles on the surface, and an intense copper effect was observed in them. In the application coded No.8, a semi-matte surface was obtained and very slight flambé effects were observed. No.9 was the most successful application in terms of flambé glazes. It is the closest example to flambé glazes with its brightness and turquoise color transitions on the surface.

Due to the pinhole effect observed in the recipe coded No.7, it was decided to improve this recipe and to increase the effect, the silicon carbide value in the recipe was increased up to %5 and the effects were observed. It was observed that as the silicon carbide value increased, the glaze surface deteriorated and swelled and the form lost its formal properties. Experiments were carried out with both copper carbonate and copper oxide with a fixed ratio, and it was found that the copper appearance on the surface varied depending on the copper compound.

While in traditional Chinese red applications, the reduction process is usually carried out in gas kilns, an alternative method was developed in this study due to technical limitations. In this method, ceramic forms were first fired in a neutral atmosphere in an electric kiln and then an enamel kiln was used for the reduction process. After the forms were placed in the enamel kiln, they were heated to soften the glaze and the reduction process was carried out there. This innovative approach has overcome technical limitations and achieved both high-firing stoneware glazes and the desired reduction effects.

Compared to traditional Chinese red glazes, the copper effect and the pinholes on the surface, which are characteristics of this glaze that can be described as "defective", break the molds of traditional glaze understanding and create textured glazes that are very popular in contemporary ceramics today.

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