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The morphology and structure of crystals in Qing Dynasty purple-gold glaze excavated from the Forbidden City

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Ancient Chinese purple-gold glaze (zijinyou) is popular for its beautiful figuration, unique allure and fine craftsmanship. To understand the crystalline nature in the purple-gold glaze, the morphology and structure of crystals precipitated in the glaze layer of purple-gold glaze porcelain fired during the Qing Dynasty were characterized by a variety of methods combining X-ray and electron-based techniques. A large quantity of single-phase twinning ϵ -Fe₂O₃ crystals with lengths of 1-3 μm , widths of less than 1 μm , and thickness of approximately 150 nm are found dispersed across the glaze surface to a depth of approximately tens of micrometers. These crystals show stratification across the cross-section of the purple glaze consisting of 4 sublayers according to the crystal size. The formation of ϵ -Fe₂O₃ crystals primarily contributed to the reddish-brown tones of the purple-gold glaze. The presence of anorthite, a strong reducing atmosphere during the firing process and the vitreous nature of the glaze influenced the growth of ϵ -Fe₂O₃ crystals. These results suggest the controllability of single-phase ϵ -Fe₂O₃ crystals by identifying and understanding the underlying chemical processes in ancient Chinese crystalline glaze porcelain, and the findings will provide insights for modern material scientists in preparing ϵ -Fe₂O₃ crystals with large sizes and high purities.

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