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ABSTRACT

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Kanazawa gold leaf, a traditional Japanese material renowned for its exceptional thinness and brilliant metallic luster, is produced through a meticulous hammering process that reduces its thickness to nanoscale dimensions. This study examines the distinct plastic deformation mechanisms and crystallographic texture evolution associated with the production of Kanazawa gold leaf. We focus on the various properties of Kanazawa Gold Leaf. By employing advanced analytical techniques such as Transmission Electron Microscopy (TEM) and Electron Backscatter Diffraction (EBSD), the research aims to analyze the microstructural transformations at the nanoscale during hammering.

Kanazawa gold leaf is fabricated using intricate hammering techniques to create a very thin film, approximately 200 nm in thickness. It has been reported that the (001) texture is formed; however, the mechanism of its formation remains unknown. We are utilizing electron backscatter diffraction (EBSD) and ultrahigh-voltage transmission electron microscopy (UHV-TEM). We found that a (011) slip system emerges in the thin Kanazawa gold leaf, which is unusual in face-centered cubic (FCC) crystals. We discuss the critical role of this (011) slip in the formation of the (001) texture.

In practical production, Kanazawa gold leaf products often vary in gold content, with several alloy elements like silver and copper (Cu). Notably, the Cu content in these products remains extremely low, approximately one atomic percent. To investigate the significance of such a low component, we analyzed both pure gold leaf and No.4 gold leaf using energy-dispersive X-ray spectroscopy (EDS) coupled with TEM. Our findings indicate that the No.4 gold leaf does not exhibit substantial changes in microstructure due to the presence of alloying elements from the pure gold leaf. However, EDS data analysis suggests that an increase in copper content significantly reduces the activity of the (011) slip system. Consequently, maintaining a low copper alloy content appears crucial for enabling the processing of gold leaf to achieve extremely thin thicknesses, as low as around 200nm.

In the Kanazawa area, materials other than gold are also thinned using the hammering process. Previous studies have reported that aluminum (Al) leaf exhibits a similar (001) texture, as indicated by XRD results. To further explore this phenomenon, we conducted experiments using EBSD and UHV-TEM. The microstructure of the Aluminum leaf was significantly different from that of the gold leaf. Some regions displayed recrystallized features, while other areas retained dislocation structures. Additionally, the texture peaks of the Al leaf revealed two distinct orientations, <110> {001} and <100> {001}. We hypothesize that Al's lower melting point, approximately

half that of gold, results in a significantly lower recrystallization temperature, enabling dynamic recrystallization during the hammering process.

Key words: Gold leaf; TEM; EBSD; the non-octahedral slip system; SFE.