Optical and X-ray spectroscopies towards understanding the coloration of celadon glazes

Angelo P. Rillera\textsuperscript{1,2}, Mayrene A. Uy\textsuperscript{1,2}, Keito Shinohara\textsuperscript{2}, Melvin John F. Empizo\textsuperscript{2,3}, Toshihiko Shimizu\textsuperscript{2}, Hideki Yoshida\textsuperscript{4}, Nobuhiko Sarukura\textsuperscript{2,5}, Hitoshi Abe\textsuperscript{1,6,7}

\textsuperscript{1}Department of Materials Structure Science, Graduate University for Advanced Studies (SOKENDAI), 1-1 Oho, Tsukuba, Japan \textsuperscript{2}Institute of Laser Engineering, Osaka University, 2-6 Yamadaoka, Suita, Osaka, Japan \textsuperscript{3}National Institute of Physics, University of the Philippines Diliman, Diliman, Quezon City, Metro Manila, Philippines \textsuperscript{4}Ceramic Research Center of Nagasaki, 605-2 Hiekobago, Hasami, Higashisonogi, Nagasaki, Japan \textsuperscript{5}New Industry Creation Hatchery Center, Tohoku University, 6-6-10 Aoba, Aramaki, Aoba, Sendai, Miyagi, Japan \textsuperscript{6}Institute of Materials Structure Science, High Energy Accelerator Research Organization (KEK), 1-1 Oho, Tsukuba, Japan \textsuperscript{7}Graduate School of Science and Engineering, Ibaraki University, 2-1-1 Bunkyo, Mito, Ibaraki, Japan arillera@post.kek.jp

Keywords: celadon glaze, optical spectroscopy, X-ray absorption spectroscopy

Glasses and ceramic glazes are introduced with colors by incorporating transition metal ions which have absorption bands in the visible region. Celadon glazes are high temperature ceramic glazes with iron (Fe) as the main colorant. Its appearance may be varied by controlling the ceramics and glaze processing parameters including the glaze composition and firing profile. Mössbauer spectroscopy studies have shown that the resulting glaze color is correlated with the bulk Fe amount and proportions of Fe\textsuperscript{2+} and Fe\textsuperscript{3+} \cite{1,2}. The presence of titanium (Ti) has also been shown to affect the color of celadon glazes \cite{1,3}. However, not much is understood yet about its contribution to the color change. In this report, we provide optical properties and Fe structural properties of celadon glazes with varying Fe and Ti additions. These glazes were characterized using optical reflectance spectroscopy and Fe K-edge X-ray absorption spectroscopy (XAS) on the glaze surfaces. The glazes showed color change from blue to green and increase in reflectance peak with the addition of Ti. However, the XAS spectra remained unchanged despite the observed color change which is inconsistent with previous Mössbauer results. Depth-resolved XAS was performed and revealed that the Fe valency proportions had changed from the glaze surface to the glaze interior. It is possible that the change in color may be correlated with Fe properties deeper into the glaze than those obtained from the surface. Hence, more spatially-resolved measurements are needed to fully probe the structural properties of the transition metal ions and understand the coloration of celadon glazes. More depth-resolved XAS measurements on celadon glazes at the Fe and Ti K-edges are under way.


This work was supported by SOKENDAI Dispatch Program SDP222303 and the following KEK PF-PAC nos.: 2022G078, 2022PF-T004, and 2022PF-T006.