XAFS and XRF studies of anti-bacterial ceramics using synchrotron radiation

Chiya Numako[1], Yoshihiro Kato[2], Satoru Yamazaki[2], Norifumi Isu[2]

University of Tokushima, Faculty of Integrated Arts and Sciences, Tokushima, Japan[1], INAX Corporated, Aichi, Japan[2]

Recently anti-bacterial techniques have been spread into daily commodities with improving consciousness of health. Silver is most common anti-bacterial chemicals for anti-bacterial consumers in Japan, however, the resource of silver is limited and it became so expensive to be used for daily commercial item. In addition, the anti-bacterial effects on silver have not been elucidated because of difficulties of in-situ chemical state analyses for these systems. In this study, XAFS and XRF analyses using Synchrotron Radiation were applied for Ag in the sanitary wares and Zn in anti-bacterial tiles which are the products of INAX co. in order to elucidate the anti bacterial mechanism of these elements and develop new anti-bacterial material instead of limited silver.

Each specimen was cut into 1cm x 1cm blocks to be used for XAFS measurements. The glaze of these specimens were examined with XRD, however, no crystalline materials was detected. From elemental analyses using EPMA, a content of silver was about 0.08wt% in sanitary ware and that of zinc was about 15wt% in anti-bacterial tiles.

XAFS spectra of the silver in sanitary ware measured in fluorescence mode at AR-NW10A with MSSD for K-edge, and at BL9A with Lytle type detector at SX-mode for L-edge in Photon Factory. XAFS spectra for zinc were measured at BL12C and BL9A with Lytle type detector.

The Ag L_{III}-XANES spectra of the sanitary indicated that chemical state of the silver was mono-valent similar to Ag2O, however, EXAFS spectra of the sanitary ware was different from crystalline Ag2O but amorphous without 2nd neighbor interactions. The Ag ion was coordinated with about two oxygens in 2.22Å.

On the other hands, zinc in the anti-bacterial tile was divalent and the local structure was similar to Zn_2SiO_4 which is coordinated with four oxygens in 1.96Å. Zinc in the anti-bacterial tiles should be cooperated with SiO4 network but its crystalinty was low.

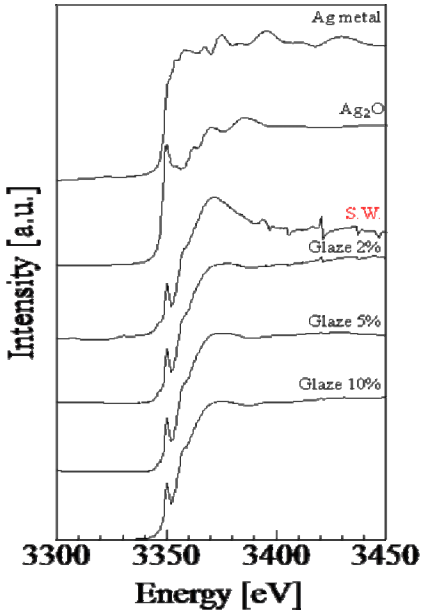

Fig. 1 Ag L_{III}-XANES spectra of the sanitary ware

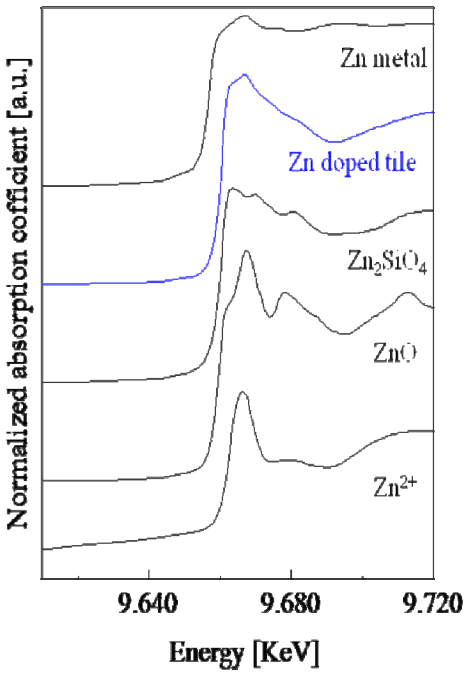

Fig. 2 Zn K_I-XANES spectra of the anti-bacterial tile