Effect of gold coating in quantitative EPMA: A MC study of monazite

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We generally use a conducting coating in electron probe microanalysis (EPMA) of geological samples to provide a path for the electron and to prevent charging. A carbon (20 – 30 nm in thickness) is the most common coating material in geological application of EPMA including the CHIME dating because of low X-ray attenuation for most characteristic X-ray lines. A gold coating has been also applied to the CHIME dating (e.g., Jercinovic and Williams, 2005) to minimize irradiation effects by electron bombardment.

One of the important problems in quantitative EPMA of rock-forming minerals is the effect of a coating film on matrix correction procedures. Correction procedures (both ZAF models and Bence-Albee method using calculated a-factor tables) have been generally established for uncoated materials. Therefore, the effect of a coating film should be carefully assessed to achieve accurate quantitative EPMA of coated materials as pointed out by Bastin and Heijligers (1991). We empirically know that the carbon coating does not cause significant problem in quantitative EPMA of most geological samples. However, it is anticipated that a gold coating has an effect on quantitative analysis through scattering of electrons because of high atomic number and density.

The Monte Carlo simulations were performed for the monazite with a 25 nm carbon and a 10 nm gold to understand effects of a coating film in quantitative EPMA at E_0 = 15 keV and 25 keV. This study used the conventional single scattering model (continuous slowing down model) with the Mott (1929) scattering using the Browning (1991) expression of the collision cross sections. The kinetic energy loss of an electron was obtained by the Bethe (1930) formula modified by Joy and Luo (1989) with the mean ionization potential described in Berger and Seltzer (1964). Intensities of characteristic X-rays were calculated by the Bethe-Powell formula (Powell, 1976). The random numbers were generated using the Mersenne Twister (Matsumoto and Nishimura, 1998). Emitted X-ray intensities were calculated using mass attenuation coefficients by Henke *et al.* (1993) at X-ray take-off angle 40°.

At both E_0 = 15 keV and 25 keV, a 10 nm gold coating distorted the depth distribution of generate Th Ma intensities in the monazite, while a 25 nm carbon coating gave the same depth distribution as the uncoated monazite. A 10 nm gold coating is 1.06 (E_0 = 15 keV) and 1.05 (E_0 = 25 keV) times higher in the *k*-ratio of the Th Mα line between the monazite and the pure thorium than a 25 nm carbon coating.

The analytical error of the Th Mα intensity of monazite is approximately 1 % RSD at general operating conditions of the CHIME dating, and the uncertainty caused by a gold coating is not negligible. Hence, a 10 nm gold coating is a factor for inaccuracy in quantitative EPMA of monazite, while a 25 nm carbon coating does not have significant effect.

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