3 - 17 Corrosion Studies of MAX Phase in Liquid Pb–Bi Alloy

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As one of candidates for the fuel cladding or structure material used in fourth generation fission and fusion demonstrate reactor, MAX phase has the properties of both ceramic and metal, such as high melting point, high-temperature stability, good erosion resistance and radiation–damage tolerance[1,2]. Max phase is a series of ceramics of nanolamellar and hexagonal structure. M represents transition element. A represents the third or fourth main group element. X represent N and C. In the design of lead-cooled fast reactor, it is required that the material should endure the corrosion of liquid Pb–Bi alloy. Therefore, understanding of the oxide layers and their growth mechanisms in LBE is fundamentally important for the development of candidate materials.

The samples were tested in the static LBE in the liquid LBE loop system in the institute of modern physics. In this experiment, the samples were exposed in LBE for 1 000, 2 000 and 8 000 h. SEM and EDS measurements were used to reveal the properties of corrosion. The voltage of electron gun is 15 keV. Possible mechanism of the formation of the oxide layer with different exposed time in LBE is discussed briefly.

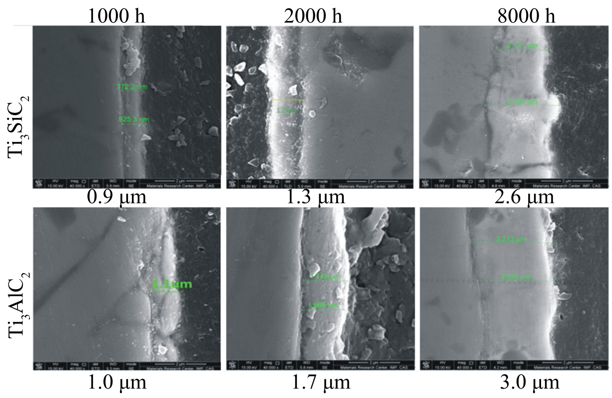

Fig. 1 (color online) The thickness of the oxide layer of Ti_3SiC_2 and Ti_3AlC_2 with different exposed time.

From the result of SEM and EDS measurements, the samples exposed in LBE with increasing time show different properties of oxide layer, such as the thickness and the element distribution. When exposed times are 1 000, 2 000 and 8 000 h, the thickness of the oxide layers are 0.9, 1.3 and 2.6 μm for Ti_3SiC_2 while 1, 1.7 and 3 μm for Ti_3AlC_2, respectively as shown in Fig. 1. To obtain the element distribution, we used EDS to obtain the layers. The corresponding EDS line is labeled. We can find that there are obvious sharp peaks of Pb, Bi and O. It means that Pb and Bi must penetrate in the surface area. The density of Ti and Si/Al is declining gradually in the first two samples as depicted in Fig. 2(a). However, in the last sample, Fig. 2(b), we find an interesting phenomenon that density of Ti and Si/Al drops and holds stable in the oxide layer. According to the experiment of A. Heinzel et al., some complicated oxide containing Ti or Al/Si must exist[3].

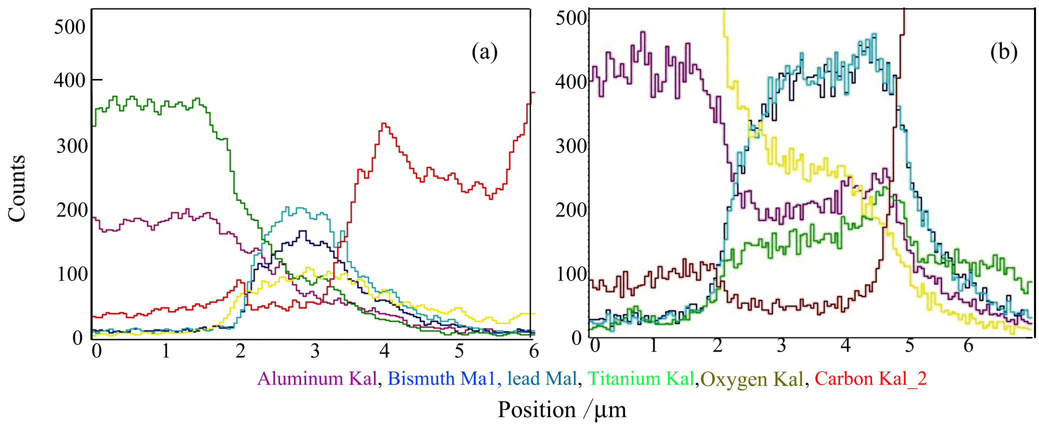

Fig. 2 (color online) The element distribution in sample with exposed times of 2 000 h (a) and 8 000 h (b).

References

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