samples are similar with the pure tungsten, which suggest that the irradiation induced vacancy like defects are mainly tungsten vacancy. The differences of (S, W) plots originate from the different surface defects and size of vacancy like defects. Therefore we conclude that the increasing S parameters with increasing fluences are mainly caused by the increasing size of vacancy like defects.

In summary, WFeNi alloys were irradiated with 260 keV H ions at 600 ℃ to flucens of 5.0×10^{15} ~3.0×10^{17} ions/cm^2. The SPAS and CDB measurements show that H irradiation induced vacancy like defects in WFeNi alloys. The open volume induced by vacancy like defects showed an increasing trend with increasing depths and increasing fluences. The size of vacancy like defects increases with increasing fluences.

4 - 5 EBSD Analysis on Static LBE Corrosion of SIMP and T91 Steels

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Due to its favorable thermal-physical and chemical properties, lead-bismuth eutectic (LBE) is one of primary candidate materials for coolant in advanced nuclear reactors. However, severe corrosion of structural materials occurs in the presence of LBE in advanced nuclear reactors, especially at high temperature[1,2]. Therefore, the selection of the structural material exposed to LBE is an extremely complex problem and compatibility tests are required. Because of their good mechanical properties under irradiation up to 500 ℃, ferritic/martensitic steels are considered to be one of the promising structural materials for advanced nuclear reactors, and so the compatibility tests of SIMP and T91 steel specimens were conducted at 450 ℃ with saturated oxygen.

Test specimens of SIMP and T91 steels were cleaned with glycerine at 150 ℃~180 ℃ after the static LBE corrosion tests in order to remove Pb-Bi from the surfaces[3]. The SEM micrographs for the surface of SIMP and T91 steels after exposing to LBE at 450 ℃ for 500h are showed in Fig. 1, it is clearly observed that the corrosion layer of T91 steel is discontinuous while SIMP steel has continuous corrosion layer.

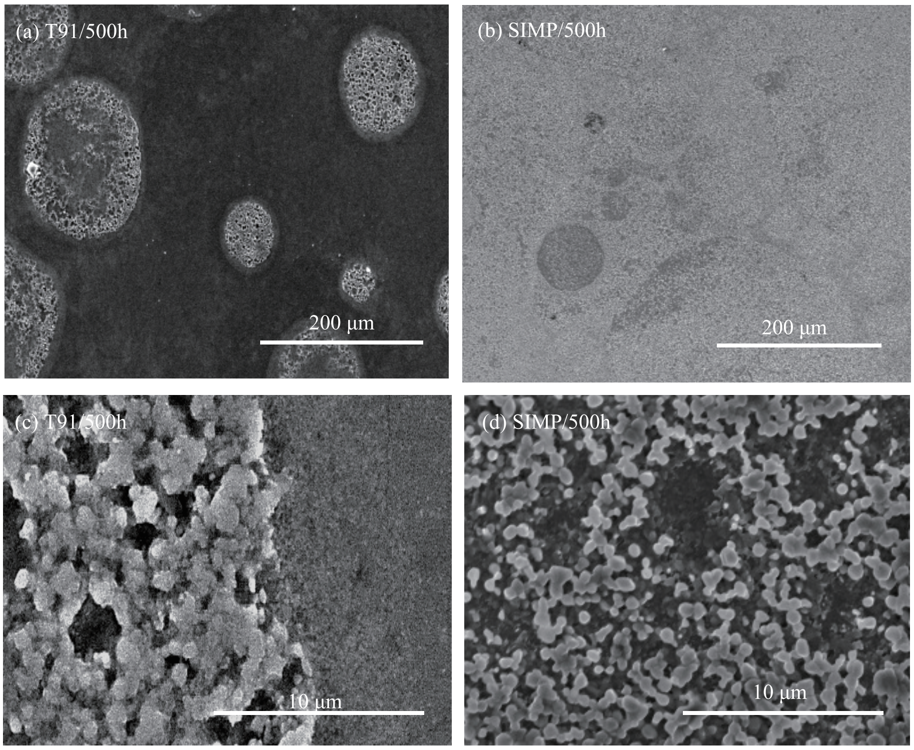

Fig. 1 SEM micrographs of the surface of SIMP and T91 steels after exposing to LBE at 450 ℃ for 500 h. (a) low magnification photograph of T91 steel. (b) low magnification photograph of SIMP steel. (c) high magnification photograph of T91 steel. (d) high magnification photograph of SIMP steel.

In order to reveal the reason of the difference of the surface of SIMP and T91 steels after exposing to LBE at 450 ℃ for 500 h, EBSD analysis was used. The grain orientation distribution for SIMP and T91 steels was showed in

Fig.2, the grain orientation of SIMP steel is not obvious, but (111) texture is clearly observed in T91 steel. Usually texture may cause the difference of corrosion speed and sensitivity in different directions.

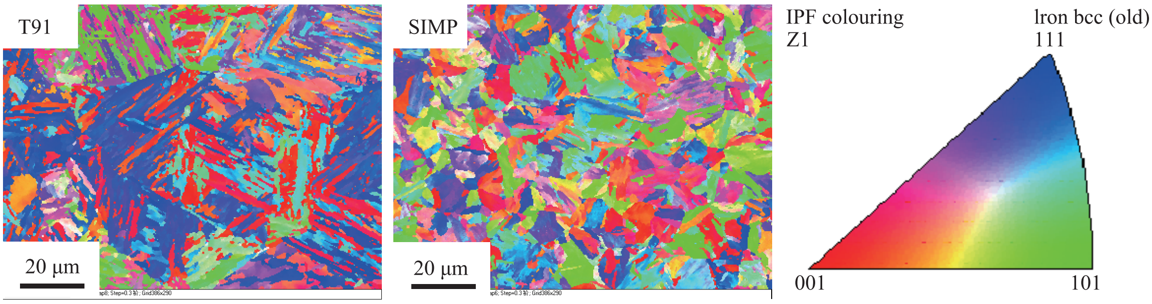

Fig. 2 (color online) EBSD analysis of the grain orientation distribution for SIMP and T91 steels.

The analysis of the fraction of the misorientation angle for SIMP and T91 steels was showed in Fig. 3. The grain boundary of SIMP and T91 steels is mainly composed of the low-angle grain boundaries which angle less than 10° and the high-angle grain boundaries which angle between 50° and 60 °, and 1.5° grain boundary is dominant. The difference of SIMP and T91 steels is that SIMP steel has about 15% more low-angle grain boundaries than T91 steel. Usually the corrosion resistance of low-angle grain boundaries is better than high-angle grain boundaries. Therefore, the difference in the grain boundaries is one factor that caused the LBE corrosion resistance of SIMP steel is better than T91 steel.

The analysis of the fraction of low-$\sum$CSL boundaries for SIMP and T91 steels was showed in Fig. 4. The percentage of low-$\sum$CSL boundaries for both SIMP steel and T91 steel is less than 5%, so the effect of low-$\sum$CSL boundaries on LBE corrosion is very small.

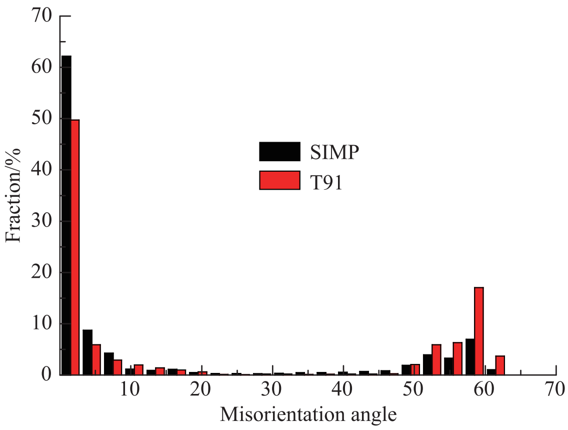

Fig. 3 (color online) The fraction of misorientation angle for SIMP and T91 steels.

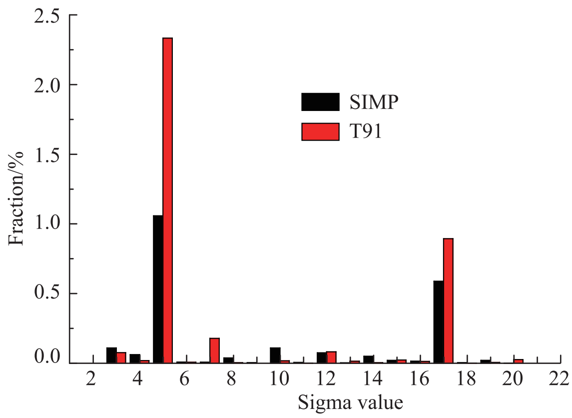

Fig. 4 (color online) The fraction of low-$\sum$CSL boundaries for SIMP and T91 steels.

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