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ON THE CHEMICAL MECHANISM OF SURFACE DESTRUCTION OF THE DIAGNOSTIC SYSTEM COMPONENTS INSIDE EAST VACUUM VESSEL

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First Mirrors (FMs) are essential plasma-facing components in all optical spectroscopy and imaging systems used for plasma diagnostics both in laboratory applications and in controlled fusion devices. They are first optical elements that face plasma directly and reflect light from plasma to various diagnostic instruments. The condition of FMs directly affects the quality and the reliability of optical measurements in plasma experiments. FMs tests were conducted at JET [1], EAST [2] and other machines. It was established a potential modification of a FMs reflectivity due to erosion-deposition processes during operations. The method of installing FMs in EAST tokamak has practically eliminated the FMs surface destruction due to erosion-deposition processes [3,4]. However, as a result of prolonged operation, surface erosion occurred and reflectivity properties were degraded. In this work causes of significant surface erosion of polycrystalline molybdenum FMs installed in EAST tokamak and operated during two experimental campaigns were investigated. The component and depths profiling analysis has been carried out by means of X-ray photoelectron spectroscopy. The surface analysis showed the dominating presence of molybdenum trioxide MoO_3, with the amounts of B, Zn, Cu, and Fe not exceeding 1%. It was established a predominance of a chemical mechanism of mirror surface erosion due to the growth and evaporation of molybdenum oxides, which have a very high volatility. It should be noted that the boiling temperature of MoO_3 at the pressure about 10^{-5} Pa is about 800°C [5]. Active oxidation of molybdenum occurring during technical breaks and subsequent heating of the mirror to a temperature of about or more than 1000°C at a pressure of a level of 10^{-5} Pa led to the evaporation of molybdenum trioxide MoO_3. Repeating the specified process multiple times during the operation of the EAST tokamak led to the development of significant macrotopography on the surface of the FM, as shown in Fig. 1 (b).

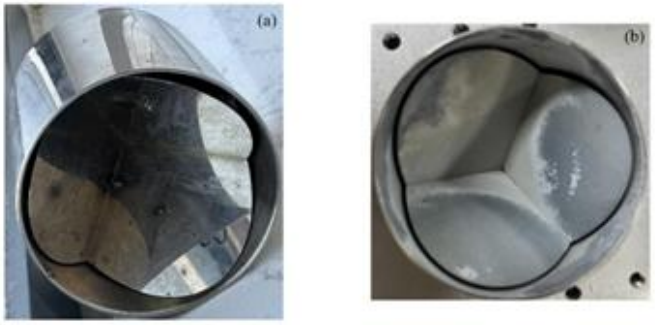

Fig. 1. EAST FMs before (a) and after (b) operation

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