Design and Development of a Getter Pump for Hydrogen Maser

Jie Xiang[1], Xueling Hou[1],Yong Cai[2], Tao Lu[3],

[1]1. School of Materials Science and Engineering, Shanghai University, Shanghai, China
[2] Laboratory of Time & Frequency Technology Research, Shanghai Astronomical Observatory, Chinese Academy of Science, Shanghai,China
[3] Shanghai Kingv Material Technology Co.,Ltd, Shanghai, China

Email: xj@kingmt.com.cn

Ultrahigh vacuum is one of the critical conditions for hydrogen master to have long-term frequency stability performance,a getter pump is the best choice. In this work,the process of research and development a getter pump for hydrogen maser is described.

In this paper, the life of the hydrogen maser is 12 years, the total hydrogen consumption is 6.3MPa.L, and the pumping speed of the getter pump is greater than 160L/s [1]. Firstly, the sorption performance of the 26mm diameter, 1.5mm thick disc prepared with four different non-evaporable getters (Zr-V-Fe,Ti-Mo,Zr-C,Ti) were compared(Fig 1(a)). The pumping speed rate of hydrogen by constant pressure method, the sorption capacity of hydrogen by constant volume method and the sorption capacity of CO by constant volume method were adopted. The results show that Zr-V-Fe has the best sorption performance. Only 256 pieces are needed to meet the target requirements.

A disk-type getter pump containing a heating device was designed with a ring plate with an outer diameter of 26mm, an inner diameter of 6mm and a thickness of 1.5mm as the getter element(Fig 1(b)). The life experiment of a single module shows that its regeneration times are more than 50. After the hydrogen maser is formed with designed getter pump, after activation, the ultimate vacuum in the hydrogen maser is 4×10^{-7} Pa, the vacuum after the hydrogen is injected is 4.6×10^{-6} Pa, the hydrogen ionization and the time frequency signal are normal(Fig 1(c)). It shows that the designed getter pump achieves the expected goal.

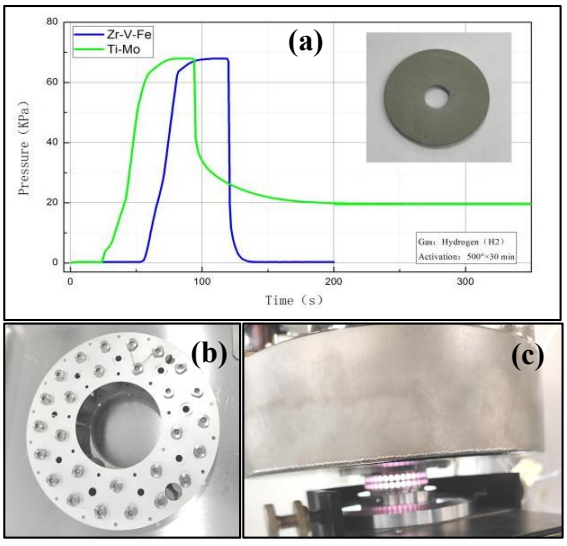

Fig. 1: (a)The test results of the hydrogen sorption capacity of two materials tested by constant volume method; (b) actual getter pump; (c)hydrogen ionization of the hydrogen maser with getter pump.

[1] Haohui Que, Wujiabei Xu , Qi Li,et al.Design of a vacuum system for space active hydrogen maser.Frontiers in Physics. 2022.970705