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Vacuum metrology technology and its application in aerospace

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In this paper, some new methods in vacuum metrology field and their typical applications in aerospace were introduced in detail. A pressure leak detection method for small volume was developed, which solved the issue about quick checking the sealing quality for cabin door of manned spacecraft, and a quick leak detector for cabin door of manned spacecraft was developed, which was successfully applied in Shenzhou spacecraft, target spacecraft and rendezvous and docking between Shenzhou spacecraft and target spacecraft, and which also provided an important guarantee for astronaut life safety and for successful implementation of China's manned space program. On the basis of static accumulation comparison principle, a measurement method for very low vacuum leak rate was proposed, and a measurement apparatus for very low vacuum leak rate for lunar sample sealing equipment was developed. The relationships between sealing structure, filling, transition layer, blade shape and angle, blade indentation depth, extrusion force and leak rate were investigated by the special apparatus, which provided theoretical and technical supports for optimal design of this sealing equipment. A lunar sample sealing equipment was developed by solving many technical challenges, including automatic switching, vacuum sealing of extremely low leak rate, and this equipment will be used in the China's third step moon exploration program. The lunar sample sealing equipment can automatically take moon sample and take samples from the surface of the moon back to earth. A gas injection approach based on double molecular flow orifice was proposed, which eliminated the gas quality discrimination effect, ensured the constant ratio of each gas after injection, and solved the technical problem of gas injection of standard gas. The inlet system of standard gas can effectively achieved the precise ratio and filling of buffer gas used in rubidium bulb of rubidium atomic clock, which reduced obviously the influence of environment temperature on long-term stability and performance criteria of rubidium atomic clock.