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Robust Design for Showerhead Thermal Deformation

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Showerhead is used as a main part in the semiconductor equipment. The face plate flatness should remain constant and the cleaning performance must be gained to keep the uniformity level of etching or deposition in chemical vapor deposition process. High operating temperature or long period of thermal loading could lead the showerhead to be deformed thermally. In some case, the thermal deformation appears very sensitive to showerhead performance. This paper describes the methods for robust design using computational fluid dynamics. To reveal the influence of the post distribution on flow pattern in the showerhead cavity, numerical simulation was performed for several post distributions. The flow structure appears similar to an impinging flow near a centered baffle in showerhead cavity. We took the structure as an index to estimate diffusion path. A robust design to reduce the thermal deformation of showerhead can be achieved using post number increase without ill effect on flow. To prevent the showerhead deformation by heat loading, its face plate thickness was determined additionally using numerical simulation. The face plate has thousands of impinging holes. The design key is to keep pressure drop distribution on the showerhead face plate with the holes. This study reads the methodology to apply to a showerhead hole design. A Hagen-Poiseuille equation gives the pressure drop in a fluid flowing through such hole. The assumptions of the equation are the fluid is viscous-incompressible and the flow is laminar fully developed in a through hole. An equation can be expressed with radius R and length L related to the volume flow rate Q from the Hagen-Poiseuille equation, $Q=\pi R4\Delta p/8\ \mu L$, where μ is the viscosity and Δp is the pressure drop. In present case, each hole has steps at both the inlet and the outlet, and the fluid appears compressible. So we simplify the equation as $Q=C(R,L)\Delta p$. A series of performance curves for a through hole with geometric parameters were obtained using two-dimensional numerical simulation. We obtained a relation between the hole diameter and hole length from the test cases to determine hole diameter at fixed hole length. A numerical simulation has been performed as a tool for enhancing showerhead robust design from flow structure. Geometric parameters for the design were post distribution and face plate thickness. The reinforced showerhead has been installed and its effective deposition profile is being shown in factory.

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인공위성 조립 및 환경시험을 위한 공기 중 부유입자 관리 및 청정실 운영 방안 연구

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한국항공우주연구원 우주환경시험팀에서는 인공위성의 조립 및 환경시험을 수행하고 있으며, 이를 위한 청정실을 운영하고 있다. 인공위성은 고 진공 및 고온, 극저온의 가혹한 우주환경에서 작동을 하기 때문에 위성표면에 흡착된 오염물질은 위성의 성능 및 효율의 저하를 초래할 수 있다. 또한, 특정 부품은 오랜 시간 높은 온도에서 노출되면 에이징에 의한 기능저하를 초래할 수 있으며, 낮은 습도는 작업 환경에 정전기를 유발하여 부품의 손상을 초래하며, 높은 습도는 부식을 야기할 수 있다. 이에 인공위성의 조립환경은 청정한 환경 및 적당한 온습도 유지가 필수적이다. 이에 본 논문에서는 한국항공우주연구원에서 수행하고 있는 청정실 유지 관리방안 및 공기 중 부유입자 측정원리에 대해 소개하고자 한다.

Keywords: 인공위성, 청정실, 부유입자, 온습도