Basic research on elastic emission processing technology for ultra smooth and zero damage optical surface

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The fabrication of ultra-precision optical surfaces plays a critical role in modern optical systems manufacturing, especially in strong light systems with ultra-smooth optical surfaces. In the traditional manufacturing process of optical components, the removal of optical surface materials mainly relies on hard abrasive particles and flexible polishing pads to achieve material removal under mechanical action. Meanwhile, the nanoscale scratches are inevitably left on the optical surface during the micromachining process. To achieve the manufacturing of ultra-smooth optical surfaces, this study proposes a hydrodynamic polishing process based on the principles of fluid dynamics. This process uses elastic spherical or disc polishing tools and controls the gap between the polishing tool and the optical surface through high-precision machine tools. forming a dynamic pressure liquid film with a pressure gradient. In the hydrodynamic polishing process, the polishing slurry was injected from the outside of the tool and enters the polishing area at a certain pressure, forming a dynamic pressure liquid film with a pressure gradient. In the fluid film, the particles were droved by the hydrodynamic pressure and shear stress impacted the optical workpiece. The abrasive particles erode the workpiece under the hydrodynamic pressure and shear stress in the fluid film. and the removal of nanoscale materials on the polished surface is achieved. In this work, the mechanism of fluid dynamics in polishing process is analyzed by computational fluid dynamics(CFD) simulation. Then, the effect of slurry and fluid film on the quality of the surface is studied, through a series of experiments. Finally, experiments shown that hydrodynamic polishing process can effectively reduce surface roughness(Ra) and obtain an ultra-smooth optical surface of 0.3nm.