Effect of Chemical and Mechanical Actions on the Micro-morphology evolution in CMP

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How to obtain atomically flat surfaces is one of the focus issues in precision machining field, and chemical mechanical polishing (CMP) is the most popular method for obtaining ultra-smooth and untrla-falt surfaces. This work focuses on revealing the influencing factors of the surface roughness of polished workpieces and exploring polishing approach. During the CMP process, the chemical characteristics of the polishing slurry, the characteristics and size of the abrasive particles, the mechanical characteristics of the polishing pad, as well as the process parameters, collectively affect the evolution of the micro-morphology of the workpiece surface. Clarifying the relationship between these factors is a very difficult but also very interesting work. This work studies the influence of various factors on the evolution of the power spectral density (PSD) of the micro-morphology of the workpiece surface, from the perspective of the chemical reaction rate and the mechanical removal rate, through typical material polishing experiments and theoretical model analysis. The research results show that the polishing slurry, abrasive particles, polishing pad, and process parameters can be explained in terms of the activation rate of surface atoms and the removal rate of activated atoms under the mechanical action of abrasive particles. On this basis, for some classical materials such as single crystal silicon and fused quartz, polishing methods for achieving atomic-level roughness is proposed, and a surface with a roughness of less than Ra 0.1 nm is achieved. This research has guiding significance for the development of atomic-level surface polishing processes.

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