Closed-loop controlled jet polishing system for generating nano-scale roughness optical surfaces

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Abstract

Fluid jet polishing (FJP) is a promising precision finishing process in which a pressured slurry of polishing abrasives and carrier fluid is pushed out through a nozzle orifice and impinged onto the surface of a workpiece; by dwell time control a time-dependent and localized material removal is created. Compared to waterjet machining, FJP utilizes a reduced processing pressure and relatively small abrasive grain size to assure a low material removal rate and thus to promote the surface smoothing of the workpiece. In FJP, material removal rate and the resulting surface roughness depend on a variety of processing parameters, e.g., mechanical and geometrical properties of the abrasive particles, concentration of the particles in the carrier fluid, pressure and attack angle of the fluid jet, standoff distance between the nozzle and the workpiece, and properties of the workpiece.

In this ongoing project, a closed-loop controlled jet polishing system was designed and constructed to ensure the system output's stability and the accuracy of the generated optical surfaces. Fluid flow on the workpiece, a visual indication of the fluid properties, will be studied as a function of processing parameters. Numerical simulations will be performed to investigate the fluid impingement behavior on the workpiece and thereafter to compare it with the experimental results. With the aid of numerical simulations, desirable optical surfaces are generated by optimizing the processing parameters.

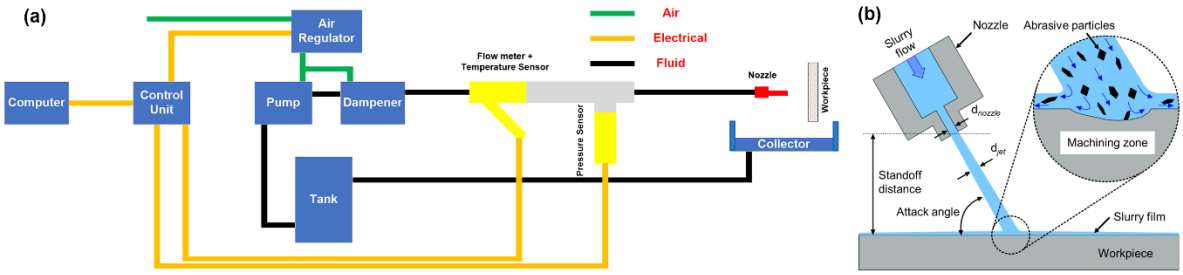

Figure 1: Sketch of (a) a closed-loop controlled jet polishing system and (b) the jet polishing process