Abstract

Polyurethane-based flexible abrasive tools are fabricated using the solvent casting particulate leaching (SCPL) method. Tools are initially fabricated with a variation in the concentration of abrasive particles. These fabricated tools with different abrasive concentrations are characterized by their abrasive distribution and mechanical behaviour. Further, the finishing performance of these tools is evaluated with experiments on aluminium alloy 6061. The tool with the best performance in terms of finishing rate and tool life is selected for further study. Surface finishing of a difficult-to-finish material, oxygen-free high-conductivity (OFHC) copper, is carried out using these fabricated tools. Results show that the OFHC copper surfaces can be finished effectively and efficiently without any surface defects, as observed in other advanced finishing processes. The finishing performance of the salt-leached tools is compared with that of the pure polymer tools in dry and wet environments. It is observed that a minimum areal surface roughness (*Sa*) of 33 nm can be achieved using both tools in series. Theoretical modelling of the process is used to estimate the contact pressure acting at tool-workpiece interface. The contact pressure and the heat flux at the interface are numerically modelled, and the results are validated with the experimental and theoretical results. A close correlation between the results is found. Electroless nickel-phosphorus-plated stainless steel with potential applications in space mirrors is used to compare the performance of the developed process with shape-adaptive grinding (SAG) and magnetorheological finishing (MRF). A minimum *Sa* of 9 nm is obtained using the flexible abrasive tools. The results obtained in terms of surface roughness are better than those of MRF and on par with those of SAG. However, the polishing pads used in the SAG have an abrasive layer at the interface, which limits the possibility of using the same tool with intermittent conditioning. The fabricated tool in this case has abrasive distribution throughout the tool structure, and the same tool can be used and uniform finishing can be achieved. Moreover, the flexible abrasive finishing tool developed offers a cost-effective solution to these processes.

Keywords: *Flexible tool, solvent casting, particulate leaching, surface finishing, surface roughness, dynamic mechanical analysis, electroless nickel*