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"NANOPRECISION ULTRA- AND ON-DEMAND MICRO-FABRICATION TECHNOLOGIES"

The main objective of our research is the development of revolutionary and new material processing technologies in electro-chemical and/or mechanical methodologies for an extensive range of materials. Through advanced research activities on ultraprecision, ultrafine, nanoprecision and ultra-smooth machining processes required for the fabrication of advanced functional devices such as optical and electronic components, we have launched research into a new field of micro-mechanical fabrication technology, in addition to surface functional modification, transcription process and feedback fabrication techniques, aiming at a wide variety of materials, precision levels, qualities and scales ranging from the micrometer to the nanometer scales to meet advanced scientific, practical and applied industrial needs. The main objective of our research is the development of revolutionary and new material processing technologies in grinding, lapping, polishing, cutting and forming of an extensive range of materials. We especially promote systematic research through the ELID (electrolytic in-process dressing) grinding project to facilitate the fabrication of precision tooling and various functional devices. In terms of actual research, a variety of parameters were studied in order to achieve a fine surface finish in ductile mode machining, and succeeded in producing highly efficient, high-precision grinding of hard and brittle materials such as Zerodur, CVC-SiC, single crystalline silicon, sapphire, MgF_2, SiC X-ray mirror materials. An ELID grinding system was mounted and a nanoprecision ELID grinding system developed to achieve the required kinetic precision and stability. These fabrication systems provide 4- to 6-axis simultaneous control drive mechanisms with a resolution of 1nm, and are capable of fabricating micro-optical device molds and other complex shapes having free-formed surfaces to ultraprecision and ultrafine definition using small-diameter tools. A 400 mm large-scale X-ray mirror was fabricated using an all-axis hydrostatic ELID mirror surface grinding machine under the XFEL (X-ray Free Electron Laser) project and SAP. We have developed an ultra-precise mechanical tool required for the fabrication of micro molds and dies with complex 3D surfaces. By applying the ELID grinding method, we successfully fabricated a nano-surfaced micro-tool with a high aspect ratio that does not cause rupture points on surfaces. We and an automotive industrial partner jointly developed the ELID Honing Process, a new method of finishing the bore portion of automobile engine cylinders, based on the ELID grinding method. Furthermore, we have developed a new surface-modifying fabrication process that generates a fine oxidation phenomenon on the surface of materials during ultra-precision mechanical fabrication processes. This method has been successfully used to produce non-crystalline oxide layers of 20 to 200 nm in thickness, and basic results in terms of improvements in corrosion resistance, tribological characteristics, wettability and biocompatibility of fabricated surfaces have been achieved. In order to realize an efficient ultrashort pulse laser for microfabrication, we have developed a ceramic Yb:YAG laser with efficiency of more than 10% higher than a CO_2 laser. As a result we were able to realize femtosecond pulse generation with a Yb:YAG ceramic laser for the first time. Much is expected of this new laser in the field of microfabrication.

BIOGRAPHY

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