Free Form Fluid Jet Polishing with In-Process Monitoring

TNO TPD delivers innovative and complete solutions for large companies, SMEs and the government.
Our fields of knowledge are: sound and vibration, models and processes, and imaging and instrumentation.
Projects, both national and international, vary from system development to consultancy.

TNO TPD is currently making strong headway on a project, for which the main objective is to combine two novel technologies, Fluid Jet Polishing (FJP) and Interferometric In-Process Measurement (IIPM), on a 7 axis machine bed. The machine will allow corrective free form shaping and polishing to less than 60nm PV (shape) and 1nm RMS (roughness). TNO TPD, together with interested parties, will investigate a range of market applications in the near future, using the machine as an experimental test-bed.

Shaping and polishing with FJP technology has the advantages that the machining equipment is low in cost, there is no tool wear, a large range of variables exist with which to optimise the process, and a large variety of slurry and work piece materials can be used.
In-process monitoring technology of material removal has the advantage that the user will experience a significant improvement in process control, of which the major advantage wil be a dramatic reduction in manufacturing times.

TNO TPD and ZEEKO Ltd
www.zeeko.co.uk
TNO TPD chose ZEEKO, a company based in the United Kingdom, to develop the machine bed. ZEEKO has a range of ultra-

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precise optical lens polishing machines. ZEEKO transformed its existing IRP600 to a new FJP600 using knowledge garnered from TPD experimental findings.
The machine is able to load work pieces weighing 150 kg with a diameter of 600 mm, and has recently become operational.

Market Application

TPD, ZEEKO, and other interested parties have thus far identified precision optics, ophthalmic, precision metal moulds, turbine blades, jewelry/watches, and prosthetic joint manufacture as the potential targets for this new technology. Potential processes include feed backward and feed forward shaping and polishing.

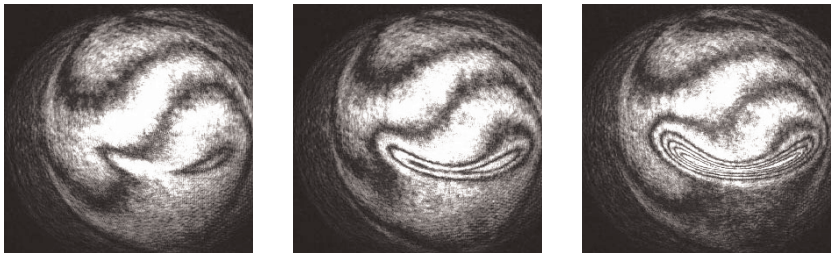
Senter IOP Funding

www.senter.nl

A large part of the funding is made available by Senter, the agency that is responsible for the execution of grant schemes on behalf of a range of Dutch ministries. The agency supports promising technology in the form of innovation oriented research programs (IOP).

References and Patents

At least five presentations regarding this research were made at ASPE and SPIE conferences during the last three years. In addition, TNO TPD has four patents pending that relates to this research effort.



Interferometric In-Process Monitoring

Current Fluid Jet Polishing Results

- A successful proof of concept single axis test bed.
- An understanding of the effects of various slurries (granite, carborundum, serium oxide, silicon carbide, and aluminium oxide) and slurry concentrations.
- Identification of other major macroscopic parameters (such as nozzle angle, nozzle shape, and jet velocity) and their relation to material removal.
- An understanding of the response of various specimen materials (BK7, silicon, CR39, polycarbonate, aluminium, steel, quartz, flint, sapphire, ruby).
- Highly variable material removal rates and spot shapes (Research has led to simulation programs to predict the shape of machined spots and tracks).
- Roughness reduction down to 10nm RMS in certain materials.

Current Interferometric In-Process Monitoring Results

- A successful proof of concept stationary measurement.
- Monitoring material removal within a 5mm diameter spot to an accuracy of 10nm.
- Various design configurations for interferometric measurement, depending on the application.

TNO TPD

P.O. Box 155
2600 AD DELFT
The Netherlands

www.tpd.tno.nl

Jacob Jan Korpershoek
Phone +31 15 269 21 77
Fax +31 15 269 21 11
E-mail korpershoek@tpd.tno.nl

Optical Manufacturing and Testing Research

Research relating to advanced optical manufacture and testing plays an important role in sustaining competitive advantage in the development of optical instrumentation. One of our primary interests is the machining of aspherics and free forms, which includes the use of non-traditional techniques.