Monitoring and Closed Loop Feedback Control of Ultrafast Glass Welding

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Introduction
High precision manufacturing of nano- and micro-sized objects has become increasingly prominent due to the current drive to fit more into increasingly smaller devices. However, while traditional macro-manufacturing systems rely on automatic feedback to detect errors and act immediately, this is a more difficult task when scaled down to the single micron or less.

Project
The overall aim of this project is the creation of a high speed ultra precision laser processing system with monitoring and feedback control to improve the processing precision and reduce error in the produced components.

The work shown here demonstrates the capabilities of the system by improving ultrafast glass-glass welding. Given the stochastic nature of the process, the system will provide guidance by: 1) terminating processing once a specific weld nugget length is reached, 2) control the focal location, and 3) validating the final weld.

Laser Processing
A control system with multiple imaging systems has been developed for the laser processing platform. The system optimizes the laser system for maximum precision by reducing both precision and manufacturing time by integrating measurement and instrumentation into a single machine.

Two imaging techniques are used: 1) optical coherence tomography (OCT) for high speed point inspection, and 2) digital holographic microscopy (DHM), for in-process 3-D monitoring (part inspection). Only OCT is demonstrated here.

Outcomes
• Ruggedized OCT system with in-process feedback control (1-D)
• Integrated system for precision 5 axis machining with in-situ control
• Use of OCT to improve glass welding processing

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