Future Research

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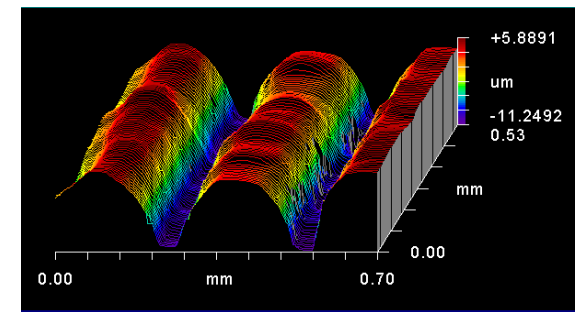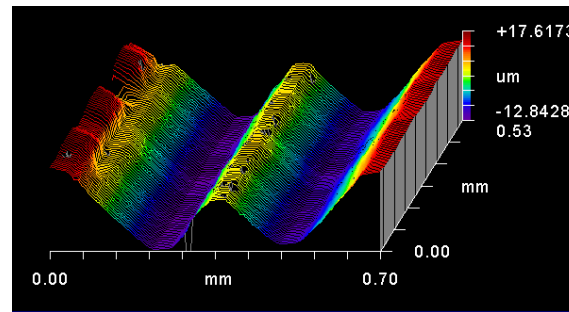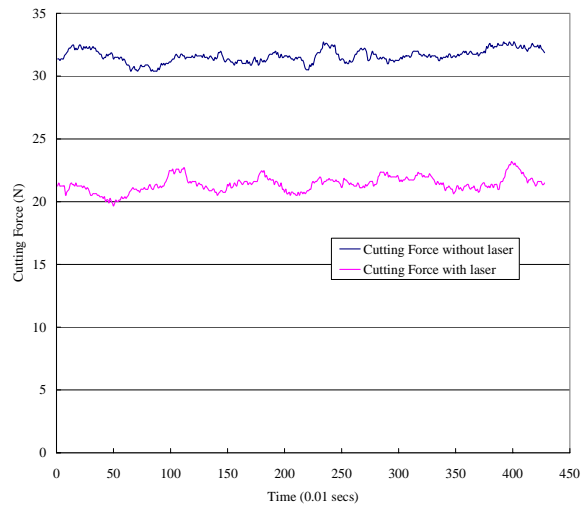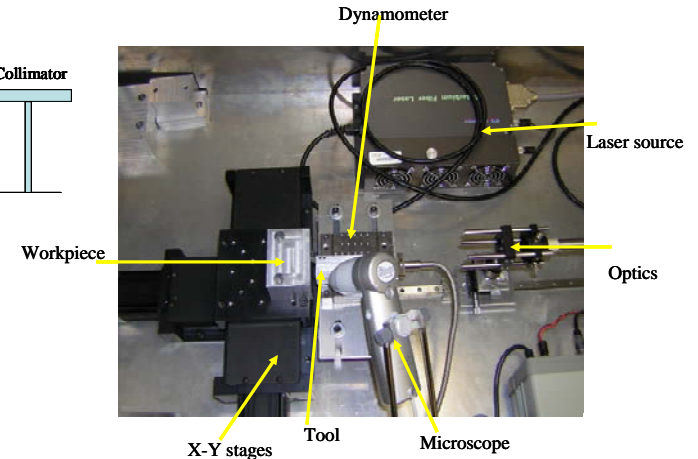*E-mail: shreyes.melkote@me.gatech.edu*
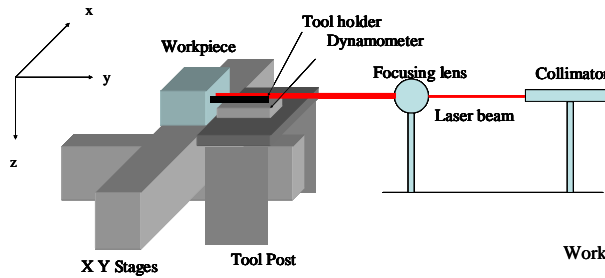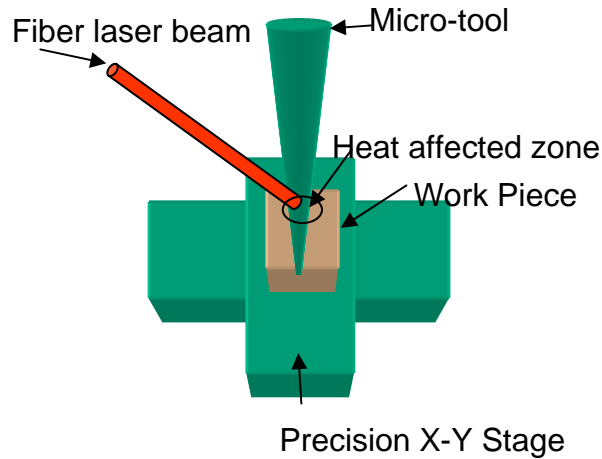*Web: http://pmrc.marc.gatech.edu/fmpr*

PMRC IAB Meeting, 15th March 2006

Laser Based Processes

- Laser Assisted Micromechanical Machining
## *- Laser Based Surface Treatment*

Further Development of LAMM Process

Fiber laser beam — Micro-tool

Heat affected zone

Work Piece

Precision X-Y Stage

Workpiece — Tool holder / Dynamometer — Focusing lens — Collimator — Laser beam

X Y Stages — Tool Post

Dynamometer — Laser source — Workpiece — Optics — X-Y stages — Tool — Microscope

Cutting Force without laser
Cutting Force with laser

+17.6173 um −12.8428 0.53

+5.8891 um −11.2492 0.53

Future work:

- Apply to ceramics (Al_2O_3, Zirconia)

- Process optimization

- Extend to micro milling

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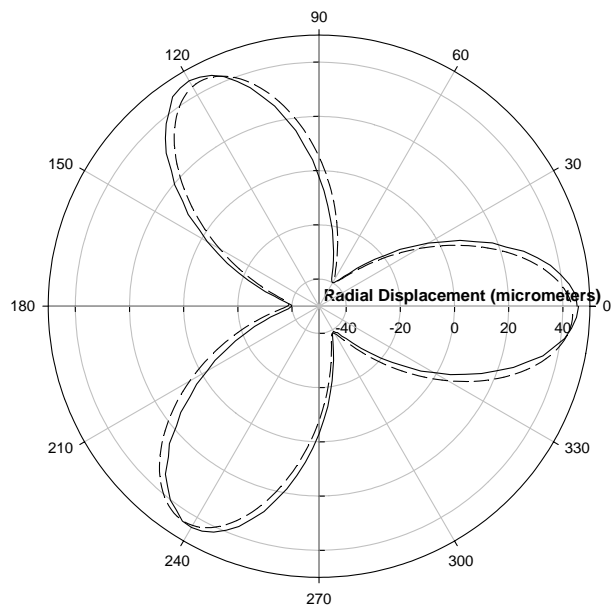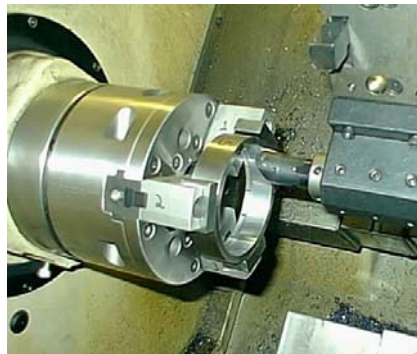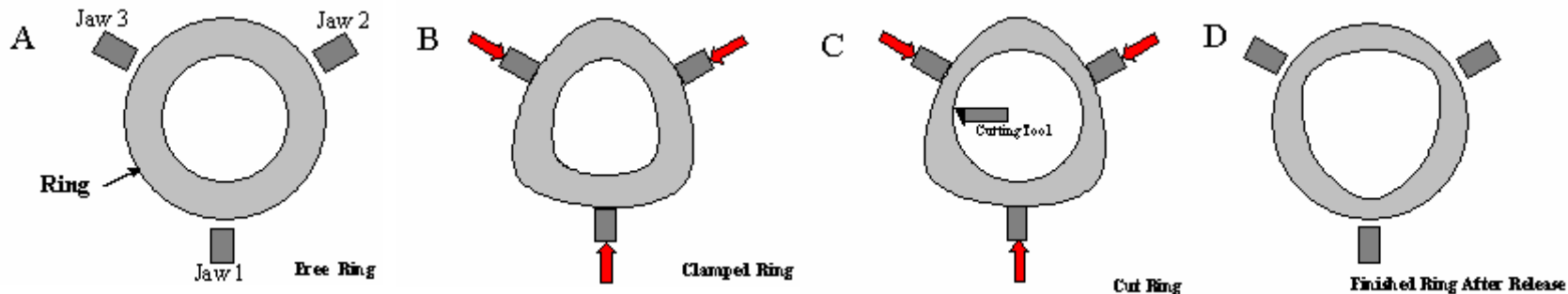
Laser Based Surface Treatment

- <u>Objective</u>: Investigate use of continuous and pulsed lasers for surface treatment of metallic and ceramic parts

- <u>Applications</u>:
  - Localized alteration of microstructure and properties (hardness, residual stress, etc.)
  - Localized surface structuring for improved tribological performance

- <u>Technical challenges</u>:
  - Control of heat affected zone
  - Optimization of laser parameters

Heat Affected Zone

10 mm/min   50 μm
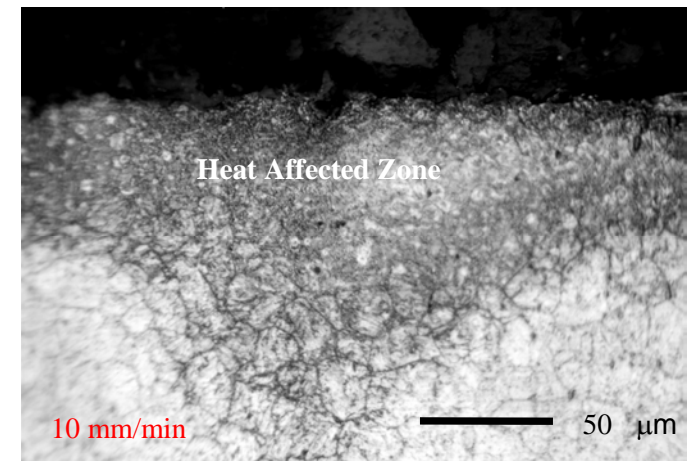
Fixturing

- Fixturing Analysis & Optimization for Precision Machining of Mechanical Seals

Fixturing Optimization for Precision Machining of Mechanical Seals *(Sponsor: Caterpillar Precision Seals)*

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Probablistic Modeling of Machining Processes

Engineering-Statistical Modeling & Robust Optimization of Machining (with R. Joseph, J. Wu, ISYE)

- <u>Problem</u>: Machining process models are deterministic whereas real process has stochastic variation

- <u>Objective</u>: Develop engineering-statistical predictive models and robust optimization methods for machining processes
  - Account for variation in model parameters, model uncertainty
  - Application to turning, milling, etc.

- <u>Technical challenges</u>:
  - Formal methods for combining complex physics-based models and empirical knowledge
  - Developing efficient methods for robust optimization when using complex process models (e.g. finite element based models)