Semester Project: Patterning functional surfaces by UV laser beam

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Start Date : March 2008
End Date : June 2008

Introduction

It is known that patterned surfaces might have improved frictional properties. The goal of this work is to process such functional surfaces using TRUMPF Vectormark UV laser beam which is a marking laser with marking software. Functional surfaces are processed on mechanical parts and cutting tool inserts with material as steel and hard metal (Cemented carbide) respectively to improve tribological and related properties.

Overview of tasks

- Acquaintance with machine
- Optimization of laser beam properties
- Patterning on cylindrical elements
- Optimization of laser beam properties with changed optics
- Patterning on cutting tool inserts
- Feed-back loop for pattern optimization
- Documentation

Potential approach to solve tasks

Acquaintance with machine

- Getting acquainted with the hardware part of the TRUMPF VectorMark UV beam laser machine
- Learning the software of the machine to control the laser beam and its functions
- Through adaptation and optimization, going beyond resources of machine to produce desired results
- Using laser vectors to pattern desired geometrical shape or image

Optimization of laser beam properties

- Subsequent to adaptation, finding the focal plane of the laser beam
- Optimizing different laser properties such as laser power, pulse frequency, velocity and internal laser parameters
- Finding the laser beam diameter in focal plane
- Determining the effects of single and multiple pass marking to produce desired depth

Patterning on cylindrical elements

- Manipulating laser beam with different parameters to pattern the functional surfaces with dimples of diameter 50μm / 150μm and the depth of 5μm / 10μm on cylindrical surfaces

Optimization of laser beam properties with changed optics

- Due to smaller dimple diameter requirement, laser beam diameter in focal plane is to be reduced
- Placing an Telescopic optic in path of laser beam to expand the laser beam by 2.5-3x, reduced laser beam diameter is achieved
- Finding new focal plane of the laser beam
- Obtaining new laser beam properties to achieve desired results
Documenting statistics of diameter and depth over laser power
Postulate control over beam to suppress parasitic effect

Patterns of Cutting Tool Inserts
- Patterning functional surface on tool insert
- Producing patterns with different geometrical arrangement of dimples

Feedback loop for pattern optimization
- Optimizing the pattern structure with feed back from tested cutting tool inserts
- To ameliorate cutting properties and tribology, optimize patterns with different arrangement and shapes of dimples and lines

Documentation
- Laser – matter interactions
- Basics of laser beam delivery theory
- Documentation of overall experimental procedure
- Key aspects of optimization
- Possible applications of functional surfaces
- Results
- Further possibilities