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Laser Texturing of Magnetic Recording Media Final Report CRADA No. TSV-1298-96

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Laser Texturing Of Magnetic Recording Media

Project Accomplishments Summary
CRADA No. TSV-1298-96
Date Technical Work Ended: May 21, 1997

Date: October 31, 2002 Revision: 1

A. Parties

The project was a relationship between the Lawrence Livermore National Laboratory (LLNL) and Intevac.

The Regents Of The University Of California
Lawrence Livermore National Laboratory
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Santa Clara, CA 95054
Audrey Marshall
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B. Background

The Commercial Laser Systems Group at LLNL developed a concept for patterning of computer magnetic recording discs.

Magnetic recording media require texturing over areas designated for contact in order to minimize friction with data transducing heads. In fabricating a hard disk, an aluminum nickel-phosphorous substrate was polished to a specular finish then a mechanical means was used to roughen an annular area intended to be the head contact band. In a previous patent (US Patent 5,062,021) it was proposed that the focused output of a low power laser with short pulse length could be used to generate the textured pattern.

However, the patterned area typically required 75,000 textured spots that needed to be rapidly (less than 10 seconds) printed with good uniformity. A means to achieve the accurate placement and uniform profile, as well as a meaningfully rapid process time, was not discussed in the referenced patent. The LLNL team devised a system that could rapidly and inexpensively accomplish the texturing.

There were three phases to the project, and each phase had its own set of deliverables.

Phase I: Concept feasibility

- Built a phase plate/grating producing a 7 x 7 array and demonstrate uniform printing of 49 spots per laser pulse

Phase II: Concept demonstration

- Built a phase plate/grating with appropriate spots (10mm diameter dimples, 200 angstrom ±20 angstrom ridge height, on 60 nm centers, approximately 7360 dimples per laser shot per side) and demonstrated uniformity, spot size and height by printing single pulse arrays
- Printed several complete annular patterns on both sides of the disk for Intevac and customer evaluation of the process

Phase III: Prototype development

- Jointly with Intevac, prepared a baseline system design
- Prepared a written specification describing a laser system for the disk printing process.
- Jointly with Intevac, prepared a design, and then built and tested a prototype system. LLNL provided support to Intevac on this step.

C. Description

Intevac, Inc., Vacuum Systems Division of Santa Clara, CA, built a disk sputtering system. At the time of the CRADA, disks needed to be patterned prior to processing in the sputtering system. It was a primary goal of this CRADA to develop a disk patterning system which could operate as a stand-alone patterning system, but which could later be integrated to operate as a station of the disk sputtering system.

LLNL built an illumination system that produced an appropriate pattern on a disk substrate. The specific pattern depended in detail on user requirements but would nominally be an annular pattern of 10 micron diameter spots spaced 60 micron in the radial direction and 60 micron along the arc length.

The annulus inner diameter would be 1.342" and the outer diameter would be 1.656". The pattern was made by an adjoining set of annular sections each with an arc of 20 degrees. Each segment was comprised of nominally an array of approximately 7360 spots.

The illumination system was composed of a laser source followed by an optical system to produce the array of spots. Depending on particular embodiments, the system would contain a specially designed phase plate and grating to produce the desired annular array of spots followed by a deflection wedge that could be designed to place the segments at the appropriate radius.

A beam expansion telescope was inserted in front of the diffraction optics to produce the required laser beam diameter to achieve a speckle size appropriate to the 10 micron spot diameter for the multiple spots in the far field. The optics produced an arc-segment with approximately 7360 spots on each laser. The assembly was rotated 20 degrees between each pulse by a planetary gear assembly allowing the prism to rotate the projected laser pattern systematically around the annulus, completing the patterning of the full annular array. In a second embodiment, the disk was rotated and the image of spots would remain stationary. The rotated disk embodiment was the first concept implemented.

In order to implement the development of a patterning system, LLNL designed a prototype system and, with the support of Intevac, engineered and fabricated it. This work included building an appropriate diffraction optic for producing the focused spots of arc-segments and then integrating optic into a prototype with a rotating disk assembly. We tested the optic and produced representative patterned disks for testing. With successful completion of the testing, Intevac licensed the technology and the LLNL staff supported Intevac's staff to engineer the process into the disk sputtering system.

D. Expected Economic Impact

The Industrial Partner: The immediate benefit of this project to Intevac, Inc. was the improved competitiveness of its products and a new market opportunity. The project increased Intevac's capabilities in the manufacturing equipment arena.

The U.S. Economy: The benefit to the U.S. economy resulted from the present future development of commercial manufacturing products that were vital to the U.S. position in the manufacturing equipment industry. This project could lead to improvements in other areas where new products being developed such as material processing, medical applications, and other areas where laser patterning is required.

E. Benefits to DOE

Laboratory Core Competencies: This project leveraged the unique capabilities of LLNL's current solid-state laser technology and newer advances in the custom design and fabrication of phase plate/diffraction gratings generating arrays of spots. Both these technologies were developed as part of the Laser Programs Directorate.

DOE/Defense Programs: The improvements and enhancements mentioned above will benefit the DOE/DP critical technologies of image generation with phase plate/diffraction grating. This technology played an important role in the NF project and other laser applications within Stockpile Stewardship.

F. Industry Area

Disk Drive Industry

G. Project Status

This project is completed.

H. LLNL Point of Contact for Project Information

The Regents Of The University Of California
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Lloyd Hackel
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I. Company Size and Point(s) of Contact

Intevac is a publicly held company with annual sales of $43 million. The company employs 200 people.

Intevac, Inc.
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Bob Weiss
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J. Project Examples

A disc patterning system was jointly built, tested and demonstrated.

K. Subject Inventions

US Patent 5,828,491
IL Number: 10016
Date Issued: 10/27/98
Title: "Phase Plate Technology for Laser Marking of Magnetic Discs"
Inventors: Clifford B. Dane, Shamasunar N. Dixit, Lloyd A. Hackel, William A. Neuman, John Honig

Documents/Reference List

Reports

ILs associated with the patents mentioned above.

Copyright Activity

None

Generated Information

US Patent 5,828,491 (LLNL Docket IL-10016) - *"Phase Plate Technology for Laser Marking of Magnetic Discs"*; issued 10/27/98; Inventors: Clifford B. Dane, Shamasunar N. Dixit, Lloyd A. Hackel, William A. Neuman, John Honig

Background Intellectual Property

US Patent: 6,037,565 (LLNL Docket IL-9860) - *"Laser illuminator and Optical System for Disk Patterning"*; issued 3/14/2000; Inventors: Clifford B. Dane, Shamasunar N. Dixit, Lloyd A. Hackel, Matthew J. Everett, John Honig

L. Release of Information

I certify that all information contained in this report is accurate and releasable to the best of my knowledge.

Karena McKinley, Director — Date
Industrial Partnerships and Commercialization

Release of Information

I have reviewed the attached Project Accomplishment Summary prepared by Lawrence Livermore National Laboratory and agree that the information about our CRADA may be released for external distribution.

Audrey Marshall — Date
Intevac, Inc.

Lloyd Hackel, Principal Investigator — Date
Lawrence Livermore National Laboratory