Quality Analysis of Periodical Microstructures, Created By Using High Frequency Vibration Excitation

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Introduction

Periodical microstructure, which is being developed in this experiment is the main part of the sensor, whose purpose is biosensing of processes, such as analysis of concentration of micro particles in biological environment.

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The aim

Find out how quality of microstructures, manufactured with novel type of vibroactive pad, changes, when high frequency excitation is used.

Objectives

- Present the process of hot imprint
- Overview the equipment, used in order to determine the quality
- Show and explain the results of examination

1 objective: Present the process of hot imprint

Description of the process

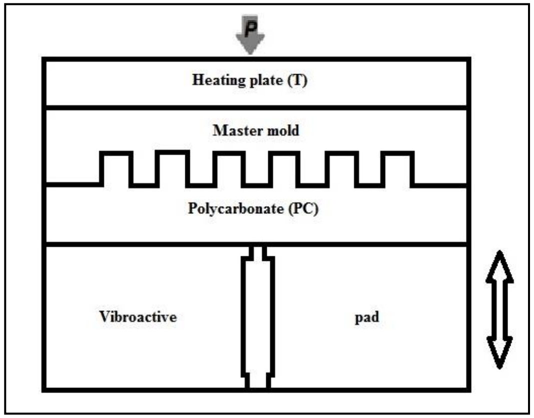

Figure 1. Experimental scheme of hot imprint process with high frequency excitation

Process of hot imprint consists of three steps: heating, pressing and demolding. First of all heating plate with master mold, attached to it, is being preheated till glass transition temperature (148˚C) of the polycarbonate, then heating plate with master mold are impressed onto the surface of polycarbonate. Vibroactive pad is vibrating all the time with frequency of 12,910 kHz, what corresponds to first resonant mode of the pad. This forces preheated polymer to flow, thus better filling the gaps between master mold and polycarbonate. Third step is lifting up of the mold

2 objective: Overview the equipment, used in order to determine the quality

Diffractometer

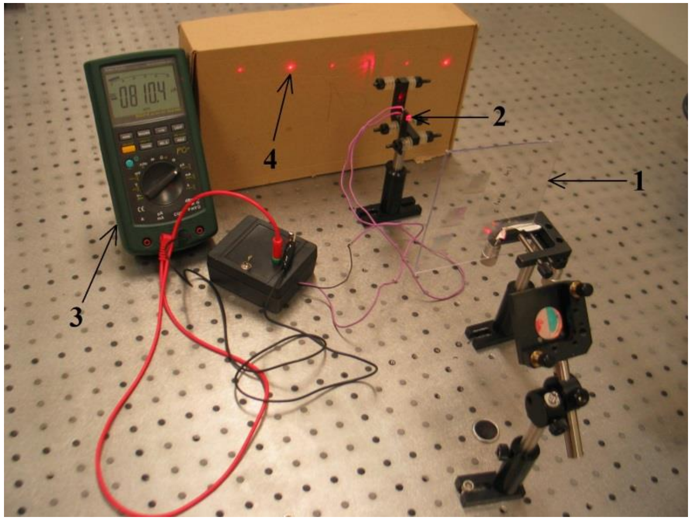

Figure 2. Diffractometer and measuring scheme (sample (1); photodiode (2); tester (3) and distribution of maximas (4))

Examination of diffraction maximas was performed by using by using laser and photodiode BPW-34. The whole scheme is connected with tester. During the measurement six diffraction maximas are obtained.

Optical Microscope

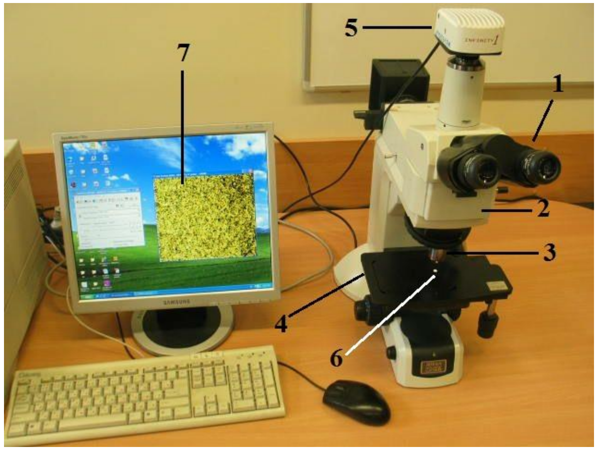

Figure 3. Optical microscope Nikon Eclipse LV 150. Trinocular tube (1); LV-UEPI2 Illuminator (2); CFI LU plan flour objectives (3); stage (4); CCD camera (5); specimen (6); view of specimen (7).

The process of optical microscopy was performed by using optical microscope NICON Eclipse LV 150. Microscope is able to magnify view 5x, 10x and 20x. The main purpose of the investigation with optical microscope is to spot defects, calculate them per area and compare different specimens.

Atomic Force Microscope

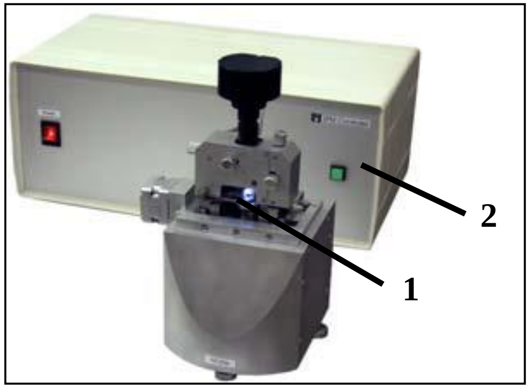

Figure 4. Atomic Force Microscope. scanning part (1) and controller (2).

Examination is performed by using microscope NANOTOP-206. Investigation of this type is able to show profile of surface view of produced microstructure and show average depth of microstructure, this is the matter of concern, since the purpose is to replicate the master mold as precisely as possible.

3 objective: **Show and explain the results of examination**

Dependency of diffraction efficiency on the specimen

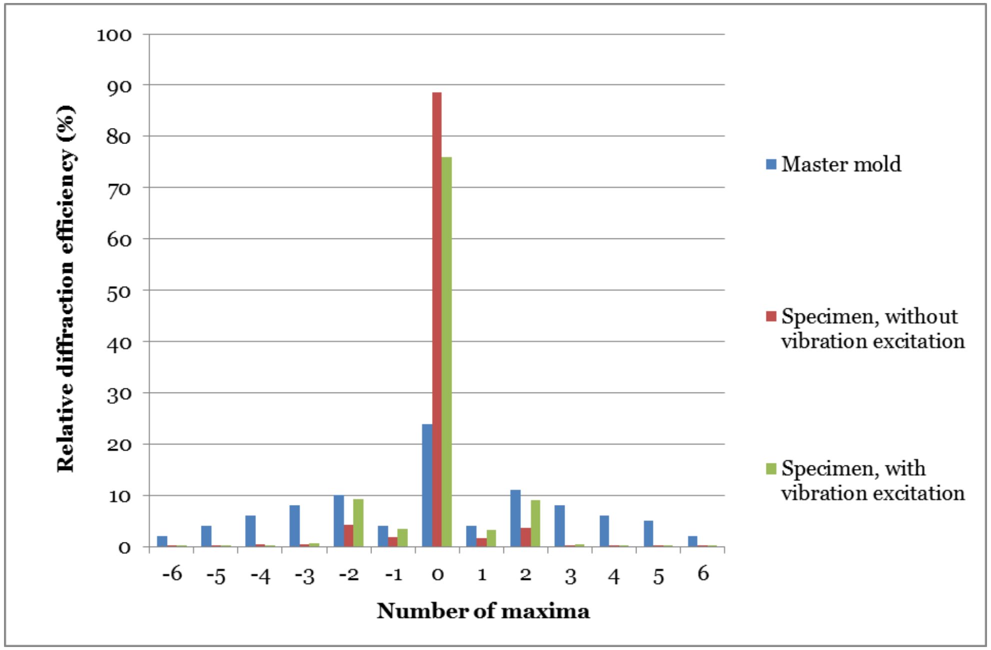

Figure 5. Dependency of diffraction efficiency on the specimen

In first and second maximas values of relative diffraction efficiencies are higher in the specimen, made with vibration excitation (3.5 % compared to 1.8 % in first maxima and 9.27 compared to 4.27 % in second maxima).

Results, obtained after the examination with optical microscope

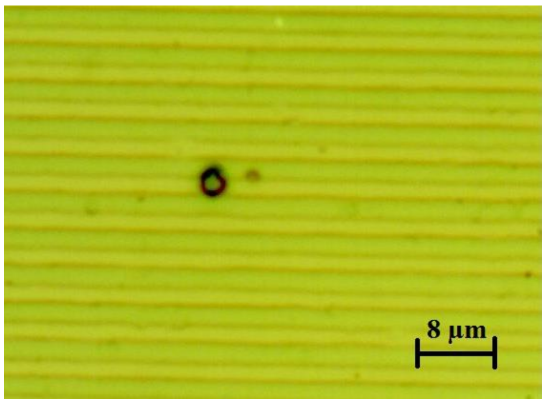

Figure 6. Master mold

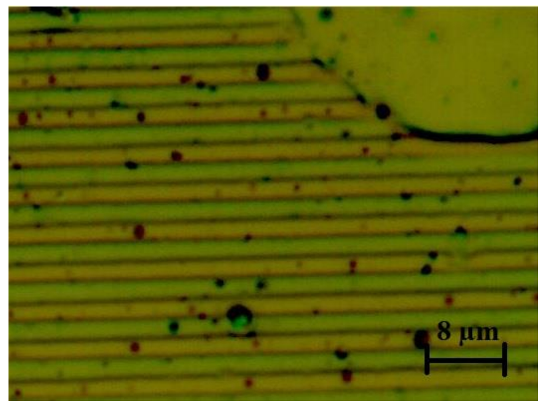

Figure 7. Microstructure, made without vibration excitation

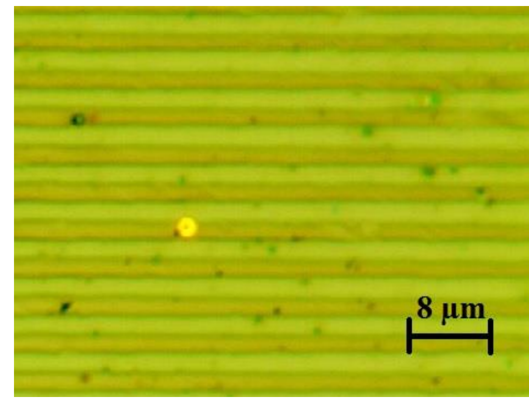

Figure 8. Microstructure, made without vibration excitation

Comment. *After the calculation of defects in images, following data was obtained: In the area of 2400 μm^2 the specimen, made without vibration excitation has 51 visible defect, while specimen, made with vibration excitation has 34 visible defects (or 1.5 times less).*

Results, obtained after the examination with atomic force microscope

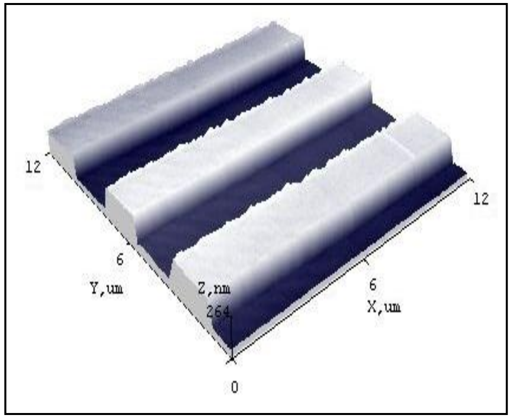

Figure 9. Master mold

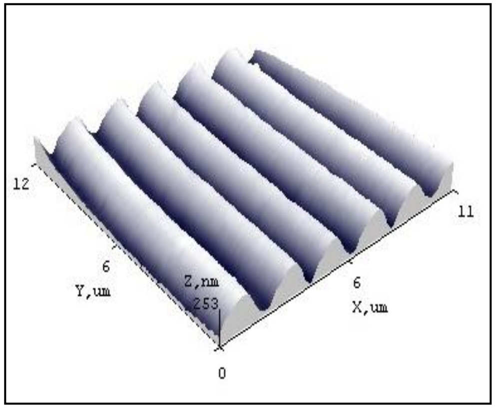

Figure 10. Microstructure, made without vibration excitation

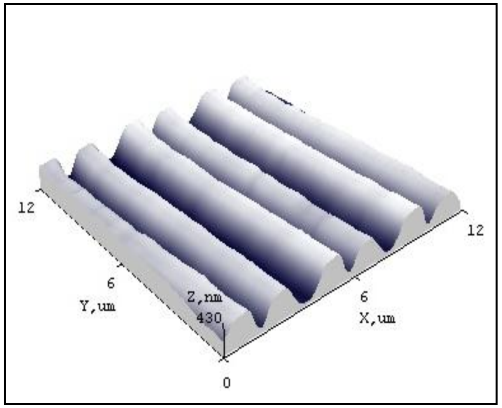

Figure 11. Microstructure, made with vibration excitation

Comment. *Average depth of master mold is 155.52 nm, depth of microstructure, made without vibration excitation is equal to 110.26 nm. The depth of microstructure, made with vibration excitation is 135.12 nm.*

Conclusions

- ✓Process of hot imprinted is described and high frequency excitation technology during the process as auxiliary measure to improve quality is presented.
- ✓Three types of measurements are overviewed. These measurements include laser diffractometry, optical microscopy and atomic force microscopy.

Conclusions (1)

✓High frequency excitation during the process of hot imprint allowed to achieve higher relative diffraction efficiency (9.27 % in second maxima and 3.5 % in first maxima) whereas these values in microstructure, made without ultrasonic excitation were: 4.2 % in second maxima and 1.8 % in first.

The amount of visible defects is 1.5 times lower in specimen made with ultrasonic excitation.

Average depth of master mold is 155.52 nm, depth of microstructure, made without vibration excitation is equal to 110.26 nm. The depth of microstructure, made with vibration excitation is 135.12 nm.

Thank you for your attention…