DIGITAL LITHOGRAPHY MASKING METHOD ON FABRICATION OF PRECISE UNIFORM MICRO-FEATURE ARRAY WITH 16 µm RESOLUTION

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ABSTRACT
Protein microarrays constitute a significant tool for studying biomolecular interactions either by employing labels (e.g. fluorescence, radioisotope) or by label-free detection methods (SPRI, AFM, EIS, MS–SELDI-MALDI) [1]. They consist of spatially arranged protein spots immobilized usually on planar surfaces. The most common industrially accessible fabrication method of protein microarrays is based on attachment of proteins on chemically derivatized glass slides [2], where protein solutions are delivered by means of high-precision printing robots [3]. In this case, limitations in spot density exist as the smallest protein spots thus realized are about 100 µm in diameter. In addition, in microarrays fabricated on derivatized glass substrates by spotting, intra-spot non-homogeneity is often witnessed (increased signal at the spot periphery compared to its center area), referred to as “coffee-ring” effect [4]. This has been attributed to the hydrophilicity of the substrates commonly used for the creation of microarrays, and in particular to the pinning of the contact line during droplet drying. Since the lack of spot uniformity deteriorates significantly the confidence in array data, the improvement of spot uniformity and reduction of spot size is required.

Superhydrophobic surface, characterized by water contact angles (CA) greater than 150°, have been attractive for various applications [5], [6]. Specifically, water repellence is useful dust-free coating, a covering that prevents snow from sticking to antennas and windows, and reduces the friction of water flow. Many plants, including the lotus leaf, naturally exhibit the unusual wetting with this kind of rough architecture. In particular, the surface of the lotus leaf consists of micron-sized hills bearing nanometer-sized wax particles with a very rough surface. It is known that the roughness of a hydrophobic surface increases its hydrophobic properties. With combination of drop-on-demand (DOD) method, this kind of surface can be a place that allows the direct fabrication of semi-spherical µ-lenses without additional processes being required.

Above two cases are example applications of the micro-feature array.

In the other hand, we have micro abrasive jet machining (µ-AJM) as a process of using impact energy from high pressurized air with micro-abrasive particles. In its basic machining principle, micro-abrasives (tens of µm), accelerated by highly compressed air or gases, forced through a micro-nozzle, and collide with hard and brittle workpieces at a very high velocity and density [7]. This method is characterized by a very high etching rate, compare with other microfabrication techniques, and does not require a cleanroom environment, which makes it extremely attractive for low cost industrial applications for machining hard and brittle materials such as glass, ceramics, etc. Here, the µ-AJM technique was performed using a SwamBlast Microabrasive sandblaster (Crystal Mark Inc). Aluminum oxide (Al2O3) with an average grain size of 17.5 µm was used as the abrasive particle in this process.

And biomachining process as a machining processes that use microorganisms to remove metal from a workpiece. This process basically utilized biological process of microorganism to cut the workpiece of metal [8]. Microorganism we used is bacteria such as A. ferooxidans and A. Thiooxidans. Thus this process can be categorized as micromachining thank to the bacteria size of about 1 um.

As the techniques for micro-fabrication both of them are usually combined with a patterned mask.
For this, based on ultraviolet light source and the digital gray-scale mask exposure technology, the digital lithography masking method is defined. It is based on the commercially available digital micromirror device (DMD) from Texas Instruments, which is used widely in DMD-based digital projectors and HDTVs. Digital lithography system consists of upper-computer system, control system and optical system. Upper-computer system is the centre of control and administration. The whole system is supervised by host computer and subsystem is controlled by MCU respectively. Each MCU exchanges information and data through computer interface. Control system is composed of several subsystems such as master-slave computer interface, step motor drive, limit switch, DMD drive, solenoid valve drive subsystem. Illumination system, digital micromirror device (DMD) and projection objective made up optical system. Emitted from light source, light beam goes through illumination system and then illuminate mask (DMD). At the same time, DMD drive is performed and mask image is shaped. Then, the image is copied to light-sensitive photosensitive by projection objective, which is coated on the substrate.

We combine this digital lithography masking method with each of the micro-fabrication technology to fabricate high-density micro-well arrays with improved spot uniformity, and micro-pillar array with resolution near of single micro-mirror size (one pixel size). The precision on combine method is shown by repeatability rate of the fabrication result.

KEYWORDS
Uniform micro feature, Precise micro array, Digital lithography

REFERENCES
