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Study on imprinting and replica molding of quasi-grey scale soft mold curved surface microstructure mold

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ABSTRACT

The aim of this paper is to fabrication of quasi-greyscale microstructures by curved surface soft magnetic mold. In this paper, a photocuring system is first developed and built independently, then created the magnetic curved surface microstructure soft mold, the magnetic force of the magnetic curved surface via to different heights was obtained after tested and recorded. The experimental results show that, under different surface curvatures and voltage control conditions, will have different quasi-grey scale array microstructures. In addition, this paper conducts research on the imprinting and replica molding of photoresist composite magnetic powder in order to discuss the formability of magnetic photoresist, and finally, the experimental result is combined with the simulation to obtain more accurate prediction and results.

1. Introduction

With rapid technological development, microsystems have been frequently applied in many science and technology fields, such as the mobile microchip, micro-optical switching, and semiconductor chip circuit layout [1,2] of the opto-electronics industry; the advanced optical waveguide system [3] of the optics field; the back light and backlight mold [4–6] of display panel systems; microactuator and micro driving motor [7,8] of the robotics field; micro runner systems [9,10] of disease detection; and micro sensor systems used for air bag restraint and micro lens systems for driving recorders [11,12]. Microsystems are widely used in contemporary science and technology, and thus, are becoming more and more important. However, the elements constituting micro system mold are common in microstructure components [13–20]. With a display panel for example, the light guide plate and diffuser plate matched to it are displayed in the form of an array microstructure. A review of actual applications in the industry shows that, the single structure and size are frequently used for periodic distribution in large areas, and thus, account for a large proportion. Regarding the light guide plate, the bigger the plate size, the larger size scope the array microstructure will need [21–30]. However, with scientific and technological progress, innovative panel manufacturing methods are changing accordingly. To achieve the needs of scientific and technological industry, the requirements of the array microstructures of curved surface light guide or non-planar uniform distribution have gradually appeared. To respond to related industrial and academic sustainable development research, this paper presents the innovation research method of quasi-grey scale array microstructure through quasi-grey scale soft mold curved surface microstructure mold imprinting and replica molding. If the grey scale gradient of the reflector plate in the LCD backlight module reactor surface microstructure (more complicated and diversified requirements) can be changed, there will be have an opportunity to have more options for design optimization, and moreover, before the application of model forming, if it is able to effectively master and predict, that duplicating test operations will be greatly reduced and the expenses arising from test errors will be greatly saved. In this paper, magnetic force is taken as the force application method, soft mold material polydimethylsiloxane (PDMS) is taken as composite magnetic powder, and a non-planar magnetic powder composition method is developed, thus, when the microstructure master pattern is under the action of magnetic force, it can obtain different magnetic forces in the position of each unit area within itself; moreover, it can be used for valid control of non-uniform height array microstructure, series formability assessment, and optical detection of microstructure finished products.

2. Experimental

2.1. Magnetic photocuring and forming system erection and inhibitor selection

The magnetic photocuring and forming system developed herein is mainly composed of a magnetic force generation part, a photocuring part, and an imprinting and forming part, as shown in Fig. 1. SU8 ultraviolet light polymerization photoresist is adopted, as it has better mechanical properties and environmental resistance (the elastic modulus of PDMS about 100,000 Pa and soft gels typically about 100–10,000 Pa) [31].

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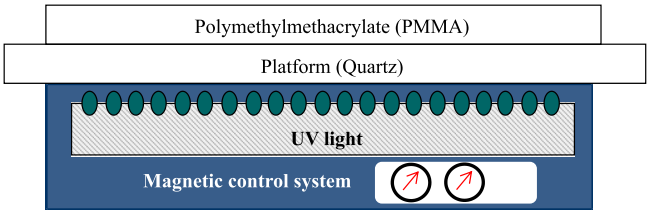
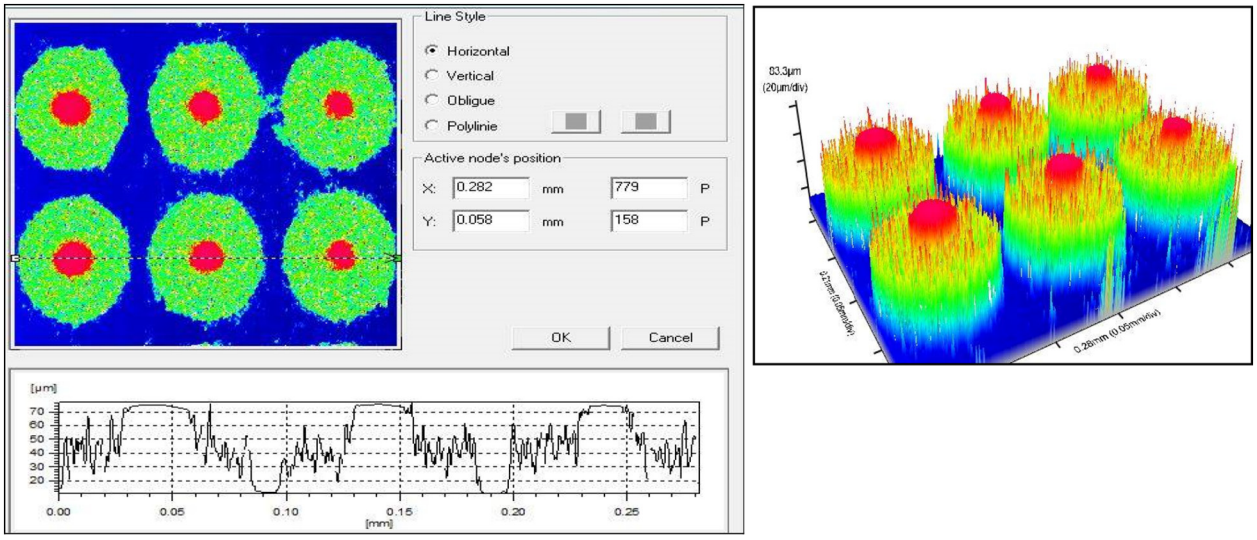


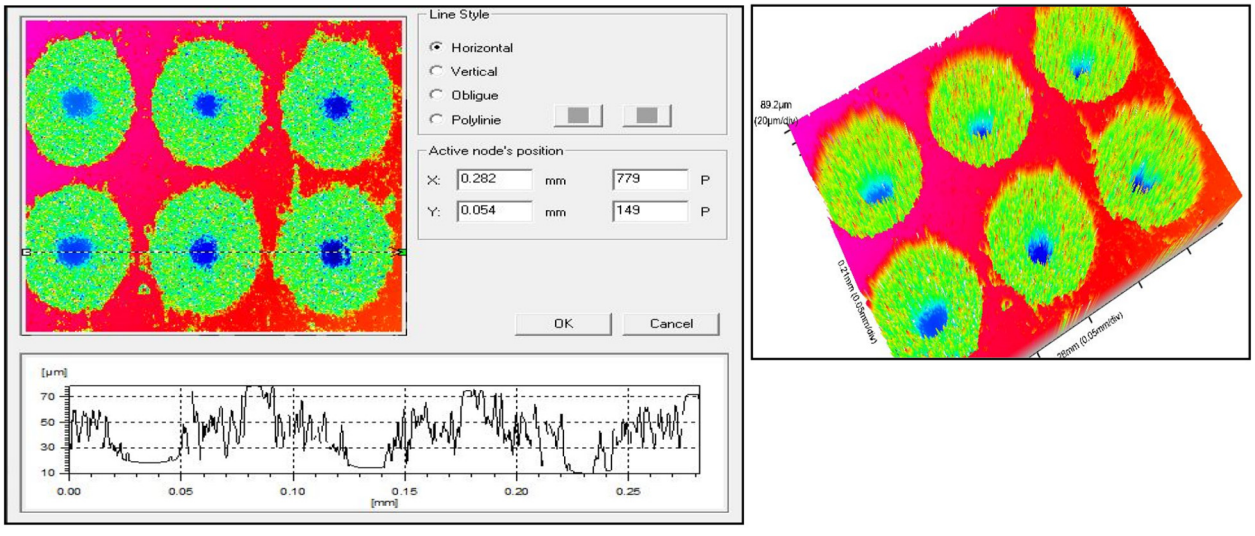
Fig. 1. Magnetic photocuring and forming system.

2.2. Magnetic microstructure soft mold preparation

Regarding the magnetic microstructure soft mold preparation part, PDMS (Sylgard™ 184, Dow Corning) is taken as the material of the soft mold, and microstructure preparation embosses into the PC (Polycarbonate) array microstructure by micro hot press and through the array microvoid of laser processing (laser wavelength: 1070 nm; environment temperature: 23 ± 3 °C; electrical power: 1.5 KW; laser frequency: 0–50 KHz). The PC microstructure, after hot pressing as adopted herein, is 178 μm in diameter and 62.66 μm in height, as shown in Fig. 2(a). Then, through PDMS rolling over, the array microstructure (microcolumn) is formed. Regarding the master pattern microstructure part, after measuring and rolling over, the microstructure is 178 μm in diameter and 62.65 μm in height, as shown in Fig. 2(b). In addition, the preparation of the curved surface magnetic microstructure soft mold (length: 32 mm, width: 32 mm and height: 20 mm) is completed through casting. First, a curved surface model is carved out through PMMA for preparation of the mold cover and magnetic material, PDMS ektexine is placed into the mold, and PDMS containing magnetic powder is poured in, in order to form a magnetic plastic box



(a)



(b)

Fig. 2. (a) PC microstructure after hot press adopted herein (b) PDMS microstructure after mold rolling over.