Deterioration Evaluation of Release Coated Surface for Nanoimprint by Macro Optical Inspection Method

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Nanoimprint lithography (NIL) is very useful for fabrication of nanopattern. And some applications are coming into practical use by NIL method (e.g. cell culture sheet, photonic crystal for LED, anti-reflection structures and so on). The key issue of mass production is comprehension of lifetime and deterioration of release coating on mold surface because adhesion of polymer material on mold surface causes defective product. However, inspection method of durability and evaluation of release layer on mold surface has not established yet. In this paper, inspection method of deterioration of release coated mold surface has been developed by macro optical inspection method.

Figure 1 shows the macro optical inspection method based on edge reflected light detection method. This macro inspection enables to grasp surface ununiformity and local defections in macro order (0.1 – few mm range) because the edge reflected light is very sensitive for undulation of surface morphology. In order to examine deterioration of release coated mold surface, silicon mold with 300 nm diameter holes and fluorine release agent (Optool DSX, Daikin, Co.) were used. The release agent treatment was as follows. At first, mold was dipped into 0.1 % release agent for 30 min. Then, mold was pulled out and baking at 100 ^{o}C for 3 min. Figure 2 shows macro image of release treatment at one time. Figure 3 shows macro image of release treatment at three times. As shown in these figures, there are several undulations were observed. And three times over coating of release agent caused a lot of defects (water marks, stripes, and coating ununiformity). The common patterns of both images such as circular pattern reflect the spin coat undulation during mold fabrication process. Thus, macro inspection method can grasp the difference of surface undulations very easily. In order to evaluation of lifetime and deterioration, UV NIL was carried out. Figure 4 shows the macro image after 56 times UV-NIL repetition using figure 3 mold. Although tiny dusts were decreased by UV-NIL transfer, main defects were clearly enhanced. The reason of decrease of tiny dusts is considered as UV polymer removed the excess release layer. On the other hand, enhancement of defect patterns is removal of release agent. Therefore, macro inspection method reveals that thin release layer behavior during UV-NIL process and deterioration of release layer and release layer undulation.

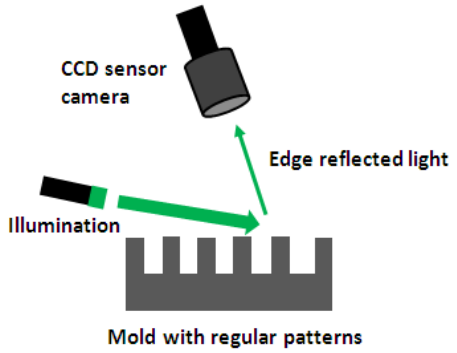

Figure 1: The concept of macro inspection method.

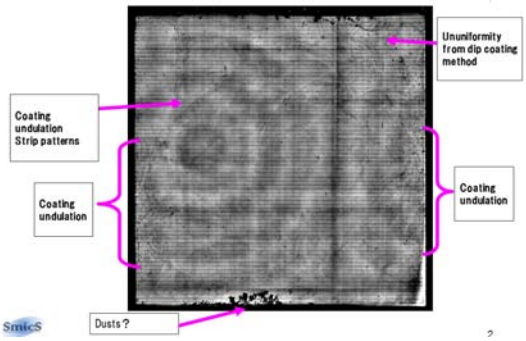

Figure 2: The macro image of release treatment at one time.

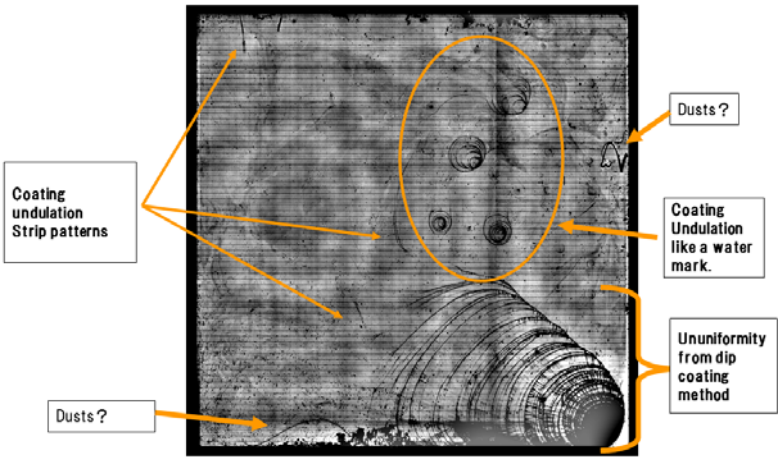

Figure 3: The macro image of release treatment at three time.

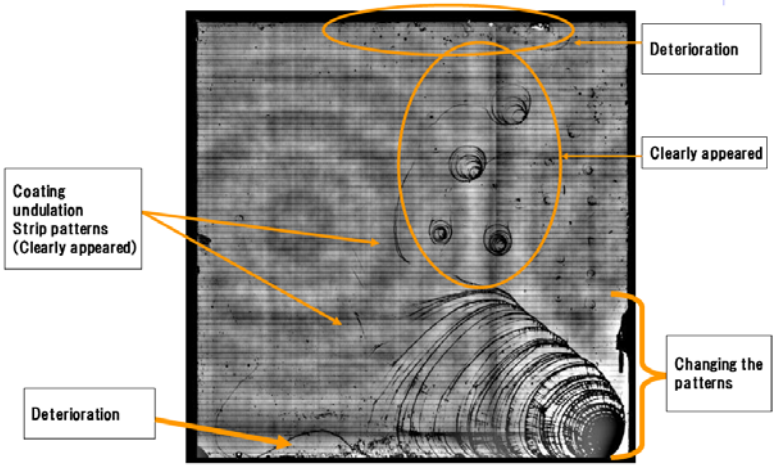

Figure 4: The macro image after 56 time repetition UV-NIL using figure 3 mold.