White Paper : “RubiQ®, Nanoimprint Equipment

Entry-level nanoimprinting equipment for R&D to pilot production purpose

Executive Summary

Increasing demand of nanoimprinting as the potential mass production fabrication technique for various application, while most of them involves the basic research in such as material selection and optical design.

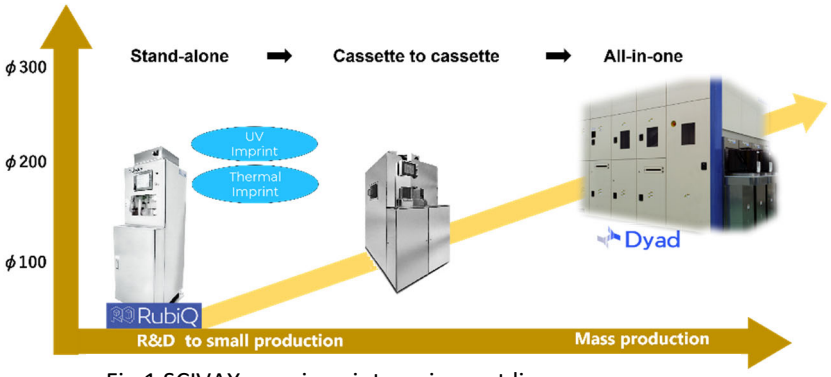


Fig.1 SCIVAX nanoimprint equipment lineup

For the preliminary R&D phase, we want to use the equipment with wider tolerancer and wider range of technological options, at the same time, we want the results and condition to be compatible with the mass production equipment as much as possible so that development results can be easily transferred to manufacturing of the product.

In response to such request, we introduce RubiQ® nanoimprinting system, which was commercialized to meet the needs for R&D to pilot production use.

1. Introduction

As shown in Fig.1, SCIVAX lines up various types of nanoimprint equipment, ranging from manual equipment for basic research to mass production use. RubiQ® is the nanoimprinting equipment suitable for the engineers and researchers ① in the R&D departments of companies that are required to develop and commercialize the advanced products within a given timeline, ② in start-up companies that needs to demonstrate the proof of concept at an early stage, and ③ in universities and research institutes that are trying to promote joint research project with companies.

In order to answer complex and demanding R&D challenges, the system has an extremely flexible platform that allows the user to freely select various specifications for the curing method either UV or thermal, the pressing method for molding, and such. It can also provide the high throughput for pilot production with a compact footprint, and the optimal HEPA filter unit and the ionizer helps to ensure stable product quality. The operational menu consists of an intuitive interface design to ensure the user friendliness.

2. Flexibility

As shown in Figs. 2 and 3, RubiQ® can be flexibly configured with resin curing methods, pressurization methods, etc. in a modular design to accommodate various nanoimprinting processes.

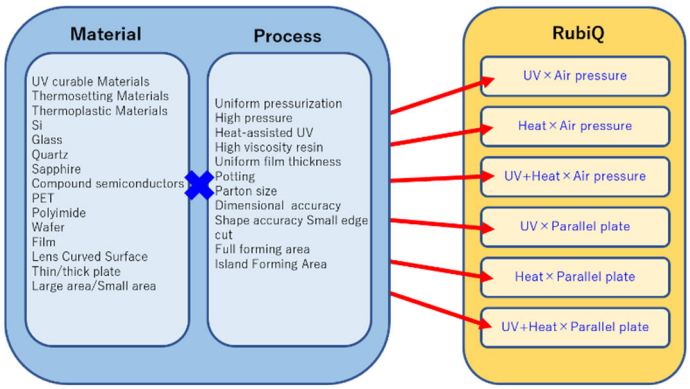


Fig.2 RubiQ®'s nanoimprinting method for various materials and processes

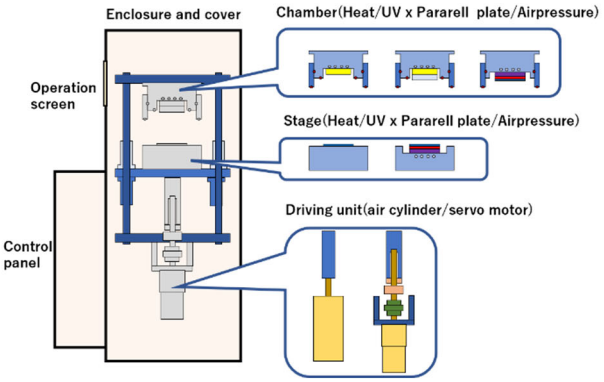


Fig.3 Equipment configurations that can be selected by RubiQ® for various nanoimprinting methods

(Molding Method) Nano-imprinting is a process in which a working mold having a micro-pattern is pressed against a resin on the substrate, the molded resin is cured by either UV radiation or heat during pressing, and then the working mold is peeled off from the molded object. The curing method depends on the type of resin to use. Fig.4 shows the equipment configuration of the FLAN method (air assisted) and the parallel plate method. FLAN method (air assisted) is tolerate to the inclination and undulation of the work, because the flexible mold is conformable to the work by pneumatic pressure. FLAN method is also suitable for imprinting the large area because its superior pressure uniformity. On the other hand, Parallel-plate method has a benefit to be more tolerate to the unknown characteristics of resin to imprint. For example in case the resin is not spin coatable due to poor leveling property, Parallel plate method can mold with the potted resin on the substrate.

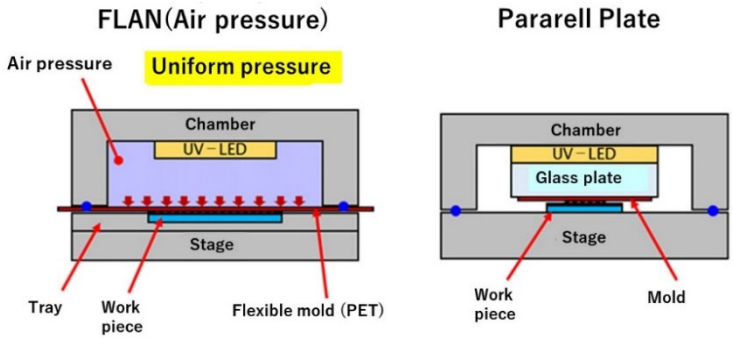


Fig.4 Selectable nanoimprint pressurization methods in RubiQ®

The UV imprinting is broadly used method for imprinting that cures resin by irradiation with UV-LED typically at λ=365nm wavelength. Since curing can be done under the ambient temperature, high pattern fidelity is secured. The thermal imprinting can directly process the thermoplastic materials that soften at the elevated temperature in the mold. This method is often used for making bio-devices, etc., where autofluorescence effect is concerned by the existence of photosensitive materials.

(Drive System) The air cylinder and servo motor systems are available as the drive system for the moving parts for pressurization. The air cylinder is the standard method because of its simplicity, but the servo motor can be selected for high-precision pressurization for parallel plate pressurization configuration.

(Extensibility) Most of the functions and options are basically retrofittable on site even after installation. This benefits when you want to upgrade the purchased equipment later.

3. Cost effectiveness

(Throughput) Vaccum environment is the default condition for SCIVAX imprinting. RubiQ® desigend the optimum vacuum circuit to minimize piping losses, thereby shortening the time to reach vacuum state. And the UV irradiation time has been shortened by increasing the UV intensity with high-power UV-LEDs, achieving a throughput of 120 s/shot under a vacuum of 50 Pa and UV radiation energy of 8 J/cm2. Fig.5 showed a sigifincant impact on reducing the throughput by 40% comparing with our conventional equipment.

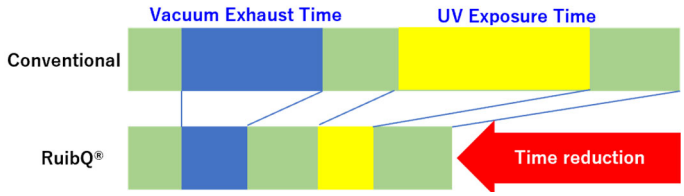
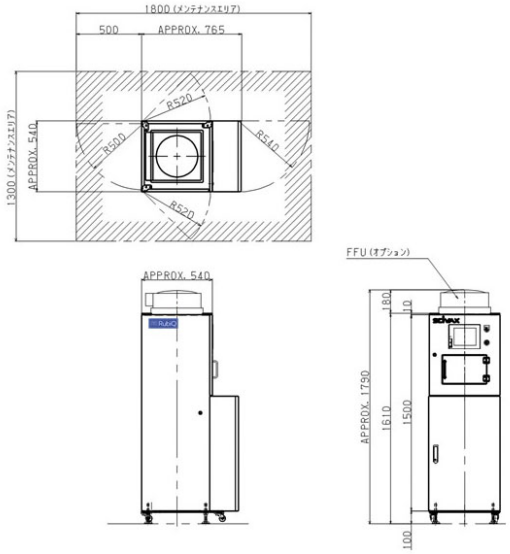


Fig.5 Throughput comparison between RubiQ® and conventional nanoimprint tool

(Compactness) Modular design contributed minimizing the space for installation as shown in Fig.6.



External Dimensions	W 540 x D 765 x H1610	Excluding options
Weight	300 kg	Excluding options

Fig.6 External dimensions of RubiQ® RD-100

4. Usability

(Intuitive interface) A process settings can be flexibly configured by directly inputting recipes. Operation guide function enables smooth operation. Skip processing, step operation, etc. are also possible.

(Automatic operation) Pressing the start button completes the pre-set process steps automatically. Automatic demolding operation is also possible in combination with the mold pin-up function to remove the mold from the work. This automatic function is optionally available.

5. Defect Reduction and Traceability

(Cleanliness measures)

Wiring and piping are eliminated around the molding chamber to reduce particle generation and make cleaning easier.

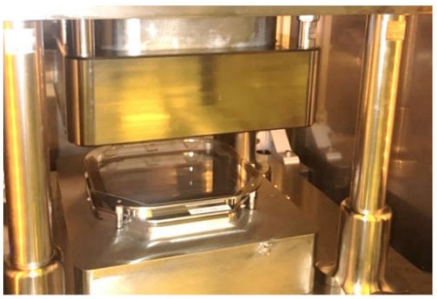


Fig.7 Molding section of RubiQ® RD-100

Optionally, a FFU unit (HEPA filter) is available to supply clean air, and an ionizer is also optionally available to eliminate static electricity around the molding section. The ionizer uses silicon electrodes for cleanliness and the ease of maintenance.

(Void prevention) All the models of Scivax NIL tool including RubiQ® is equipped with the vacuum function to attach the working mold to the work before and during pressurization in the vacuum environment. It helps preventing the entrapment of the voids in the structure.

(Traceability) All the processing data is automatically stored in the storage as event logs and process logs, and can also be retrieved in CSV format as needed.

6. Molded examples with RubiQ® RD-100

Examples of molded pattern with RubiQ® RD-100 are shown in Figs. 8-10.
(Example of molding by UV-FLAN method)

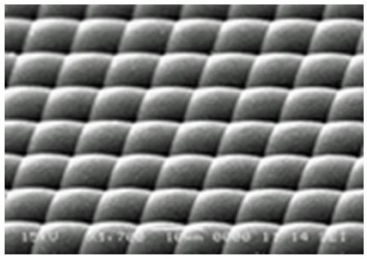


Fig.8 Micro lens array

Workpiece : □75×0.4mm glass
Mold : Flexible mold
Resin : PDMS
Lens size : 30×25μm Height16μm

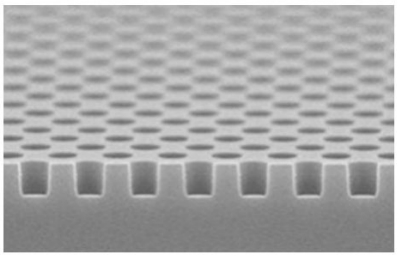
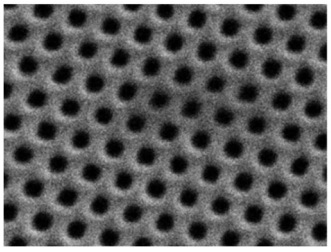


Fig.9 Hole Patterns

Workpiece : ϕ100×0.52mm Si
Mold : Flexible mold
Resin : UV resist
Pattern size : Diameter ϕ230
Pitch 460nm
Depth 200nm

(Example of molding by Thermal-parallel plate method)



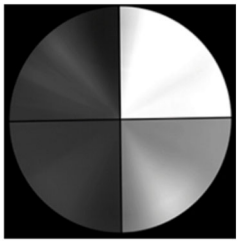


Fig.10 Hole Patterns

Workpiece : Thermoplastic □120mm t=100μm
Mold : ϕ100 Si
Pattern size : □100nm Pitch200nm Depth150nm
□150nm Pitch300nm Depth150nm
□200nm Pitch400nm Depth150nm
□250nm Pitch500nm Depth150nm

7. Customer Support

SCIVAX offers tool purchasers the privilege of online technical support (time-limited) by our technical experts, who can answer questions related to nanoimprinting based on their years of experience and know-how accumulated through more than 1,000 cases.

We can also support consumables such as master molds, replica molds, and resins.

8. Line up

Currently, 4-inch type RD-100 is available for sale.
8-inch type RD-200 is currently under design and will be released soon.