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## **Supplemental Information**

## Self-powered switch-controlled nucleic acid extraction system

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## Microfluidic channel with manual on-off valve

Sequential injections of reagents are necessary for multi-step reactions for microfluidic device operation. For the sequential injections, several independent reservoirs with corresponding valves are urgent. Therefore, we suggested poly (methyl methacrylate) (PMMA) switchgear fabricated by a CO<sub>2</sub> laser cutting method and tested functions of sequential injection and valve. Fig. S1 represents the PMMA prototype of the microchannel attached switchgear component and several combinations of operating conditions. The switchgear component consists of movable switchgears and a body part including working space for the switchgears and rubber O-rings (Fig. S1(a)). On the switchgear, the designed microchannel was attached by a double-sided tape. In addition, to effectively transmit applied negative pressure from a vacuum syringe pump to a reagent, rubber O-rings were inserted between the inlet of a microchannel and the outlet of a reagent reservoir and held by metal screws and nuts. Fig.  $S1(b) \sim (d)$  show combinations of operating conditions such as; (b) off-on condition, (c) off-off and on-off conditions and (d) on-on condition. As shown in Fig. S1(b), a blue color ink was flowed into a microchannel when the inlet of microchannel and the outlet of switchgear are connected under continuously applied negative pressure from a vacuum syringe pump. In order to test shut-off ability of a switchgear, the switchgear was immediately pulled for the disconnection of the coupling holes (off-off condition). As a result, the initial point of air gap in Fig. S1(c) indicated the off-off condition. By pushing the left switchgear, red color ink was injected into a microchannel (Fig. S1(c); on-off condition) and red/blue color inks were evenly introduced from both reservoirs after inserting the right switchgear (Fig. S1(d); on-on condition). Through the functional testing, the on-off valve function of a switchgear was investigated and the switchgear would be used for a pump operated by negative pressure.



Fig. S1 (a) Image of a PMMA microchannel attached switchgear component consisting of two movable switchgears and two-inlet meandering microchannel. Rubber O-rings were inserted below two inlets of a microchannel to effectively transmit applied negative pressure from a vacuum syringe pump to reagents. Images of functional test results of the switchgear component under continuously applied negative pressure with various operating conditions; (b) off-on condition by pushing the right switchgear, (c) off-off condition by pulling both switchgears and on-off condition by pushing the left switchgear and (d) on-on condition by pushing the right switchgear. The right reservoir was immediately pulled to test shut-off ability of a switchgear based injection controller with the initial point of air gap in (c). For on-on condition, red/blue color inks were evenly introduced from both reservoirs.



**Fig. S2** Captured images from experimental video for the measurement of plunger velocity. Using blocked syringe and opened syringe as an actuating syringe and a working syringe. At the initial state, binding two syringes and compressing plungers to 48.1 mm location from syringe head (left captured image). With releasing the syringes, measuring elapsed time during the movement of syringe plunger from 48.1 mm location to 49.8 mm location and calculating the flow rate of pulled air into the working syringe by multiplying the cross-section of cylinder and plunger velocity (moving distance 1.7 mm divided by elapsed time 4.2 s) (right captured image).



**Fig. S3** Schematic diagram of microchannels in a microfluidic component; (a) detailed design of microchannels (unit: mm), (b) fluidic pathway with the operation of the first unit of the SSENS, (c) fluidic pathway with the operation of the second unit of the SSENS and (d) fluidic pathway with the operation of the third unit of the SSENS.