The fabrication process of the fluidic channel

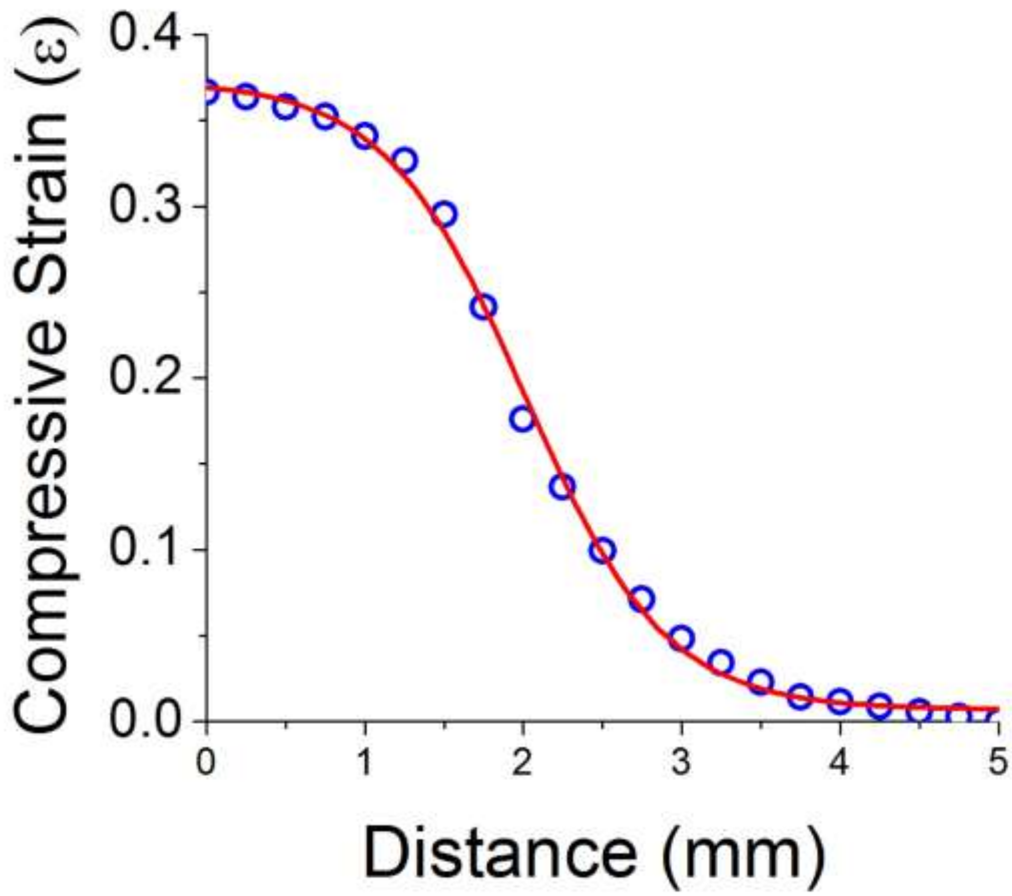
7.5g of SU-8 100 photoresist (Microchem Corp., Newton, MA) was poured on a 3-inch silicon wafer and soft-baked at 120 ºC for 12 hours. the UV lithography was processed at exposure dose of 2800 mJ/cm^2. Then, post-exposure bake was performed at 65 ºC for 30min with 3 ºC/min ramping rate. Finally, the substrate was developed using SU-8 developer (Microchem Corp., Newton, MA). For the PDMS replication, uncured PDMS polymer solution was dispensed over the patterned silicon molds and cured at 80 C° for 2 hours. Afterwards, cured PDMS was peeled from master mold and oxygen plasma was used to treat PDMS substrates to be bonded on glass substrate.

Measurement of compressive strain

In order to measure the compressive strain of ferrogels, DC voltage (0 – 7V) was applied to the mechanical vibrator to maintain the distance between magnet and magnetoactive sponge during the measurement process. The distance was increased as 0.25 mm step by controlling the applied DC voltage. The deformation of sponge was recorded as 3456×2304 pixel images. From the recorded images, the compressed rate was calculated and compressive strain was obtained from following equation:

$$\varepsilon = \frac{L_0 - L}{L_0} \tag{1}$$

where L_0 is the height of the sponge at initial undeformed state and L is the height of the sponge at current state.



Supplementary Figure 1. Compressive strain in the magnetoactive sponge as a function of distance between the magnet and sponge.

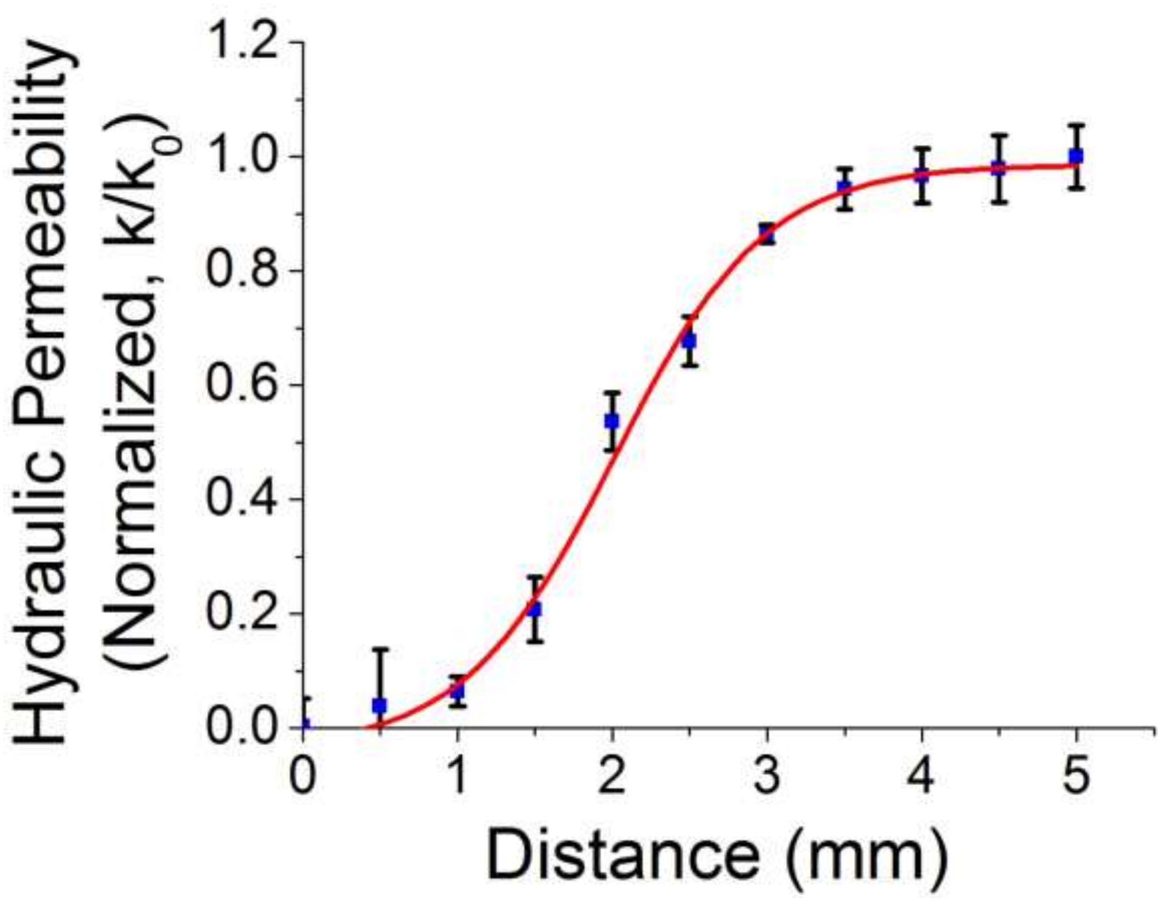
Measurement of hydraulic permeability

The hydraulic permeability was obtained using a gravity drop method. 1ml syringe with PE 50 tubing was connected to fluidics channel integrated with magnetoactive sponge. Prefilled fluid at the certain height was flowed through the sponge due to the gravity and the flow rate and pressure drop recorded. Due to the porosity difference of sponges, the flow rate varied. Hydraulic permeability was calculated from Darcy's Law:

$$Q = \frac{-kA}{\mu}\frac{\nabla P}{L} \qquad (1)$$

Where, Q is the flowrate, k is the hydraulic permeability of the sponge, A is the channel cross section, ∇P is the pressure drop, and μ is the viscosity.

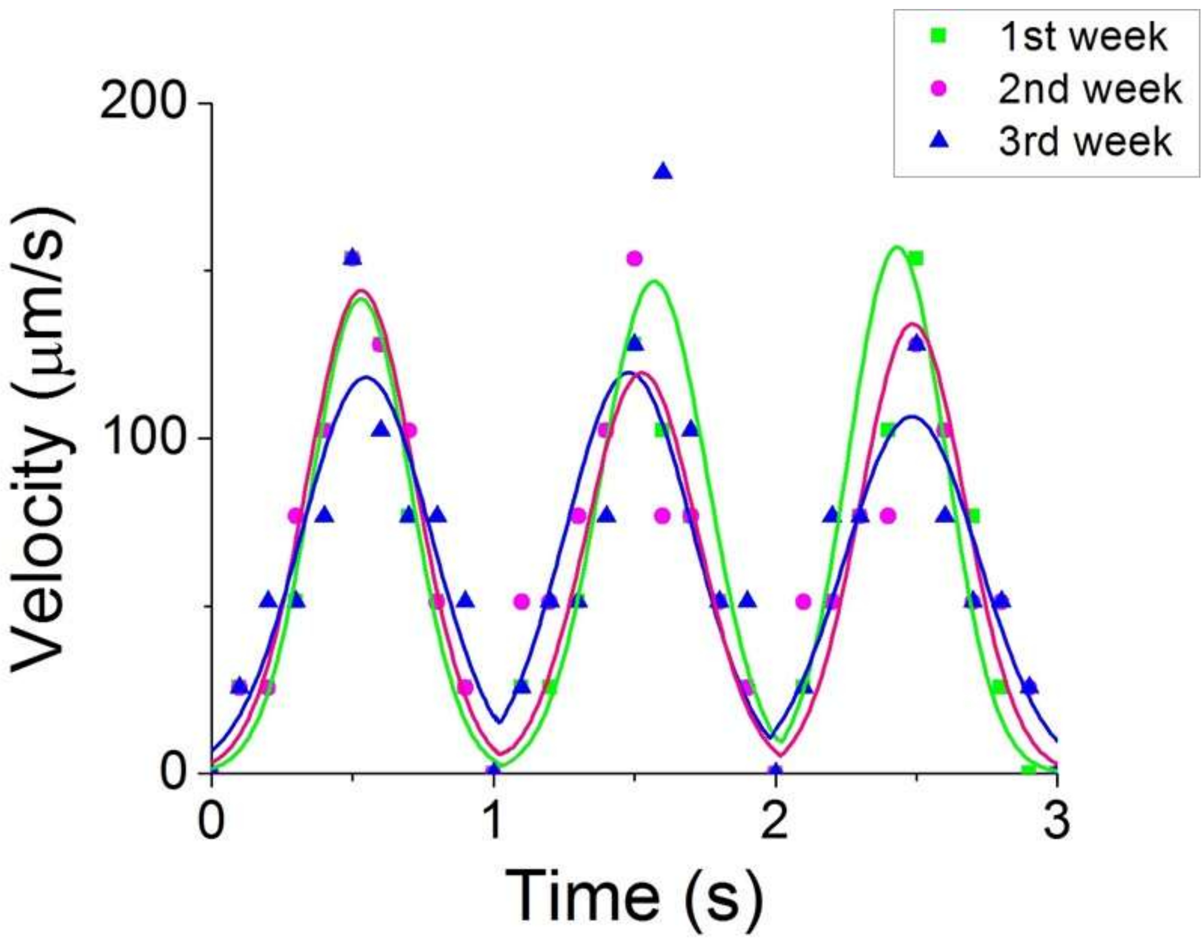
Supplementary Figure 2 shows that hydraulic permeability increases as the distance between magnet and sponge increases. When the magnet approaches the sponge, the sponge is compressed, leading to a decrease in the pore size. As a result, the permeability of fluid through the sponge decreases.



Supplementary Figure 2. The normalized hydraulic permeability of the magnetoactive sponge as a function of the distance between the magnet and sponge.

Long term fatigue test of sponge

The fatigue of the sponge had been tested for 3 weeks. The fluidic device containing sponge was connected to a peristaltic pump (P720, Instech Laboratories, Inc., Plymouth Meeting, PA) for the circulation flow. The pump was continuously operated with a speed of 3µl/min for 3 weeks and the mechanical vibrator generated the sinusoidal input pattern at 1Hz frequency. The flow pattern was measured once a week to check the functionality of sponge. Supplementary figure 3 indicates that the sponge was working well for 3 weeks.



Supplementary Figure 3. Flow profiles for long-term fatigue test of the sponge with an average flow rate of 3µl/min and frequency of 1Hz.