Supporting Information

Syringe-Injectable, Self-Expandable and Ultra-Conformable Magnetic Ultrathin Films

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Table S1. Young's moduli of SMP microsheets with T_g of 25 and 55˚C.

T_g (˚C)	Thickness (μm)	Young's modulus (MPa)								
		0˚C	10˚C	20˚C	30˚C	40˚C	50˚C	60˚C	70˚C	80˚C
25	4.2	1296 ± 189	1019 ± 165	470 ± 170	33 ± 2	25 ± 9	N.D.	18 ± 5	N.D.	N.D.
55	4.6	N.D.	N.D.	1455 ± 214	N.D.	1118 ± 348	481 ± 149	236 ± 44	8 ± 4	7 ± 2

Figures S1-S8:

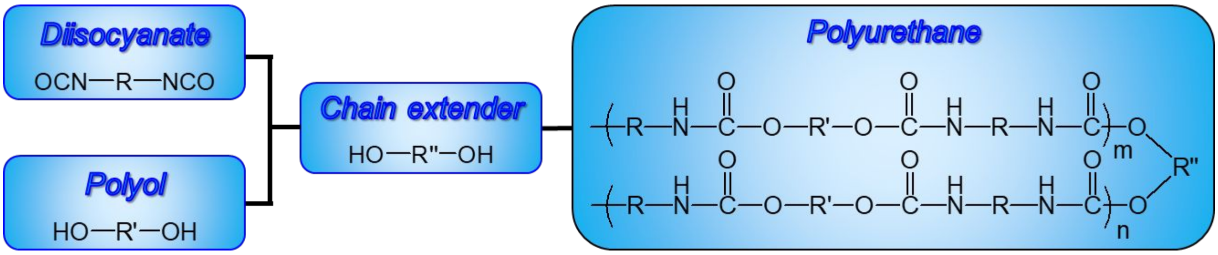

Figure S1. Chemical structure of thermoplastic polyurethane shape memory polymer (SMP).

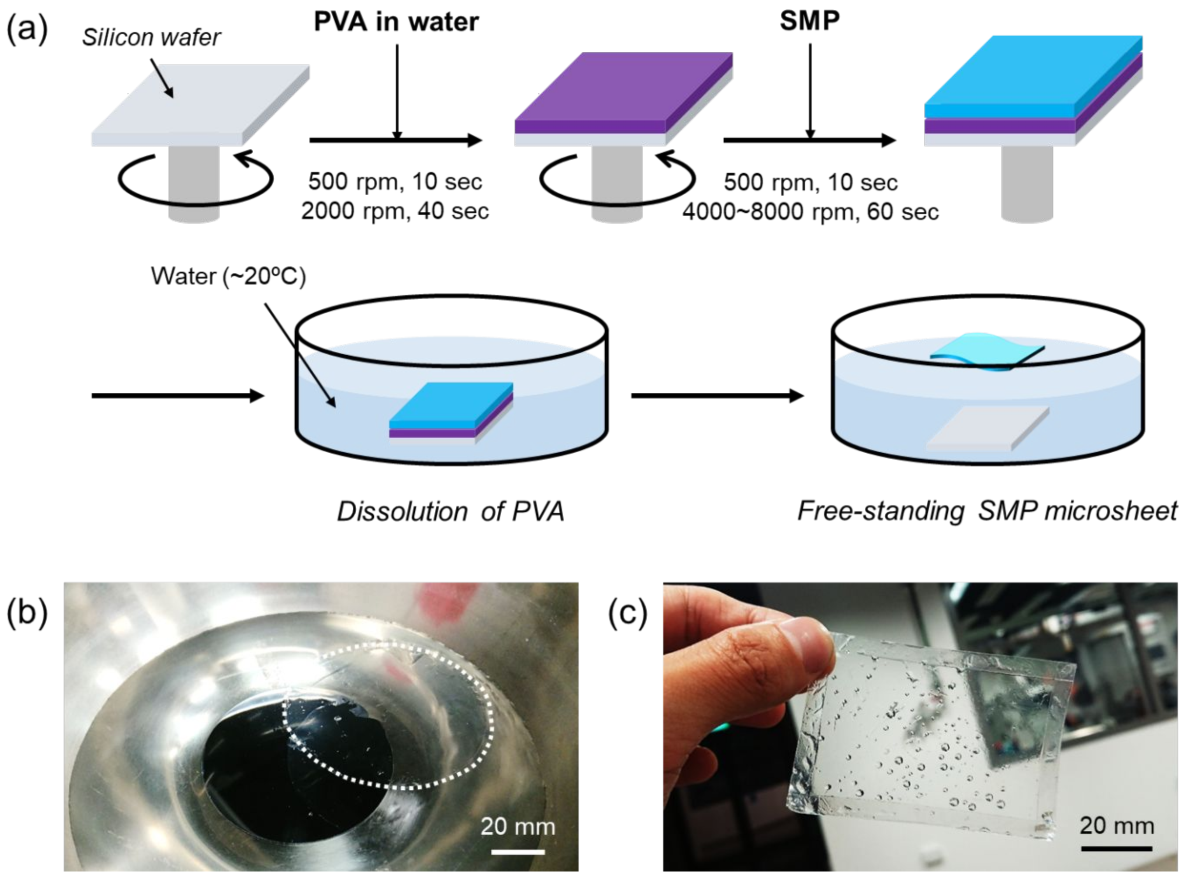

Figure S2. Sacrificial layer method to farbicate free-standing SMP microsheets. (a) Schematic illustration of the procedure for fabricating free-standing SMP microsheets by a water-soluble sacrificial layer method. (b) Image of a free-standing SMP microsheet with the size of 3“ silicon wafer floating on water. (c) Image of a free-standing SMP microsheet supported by an adhesive tape frame.

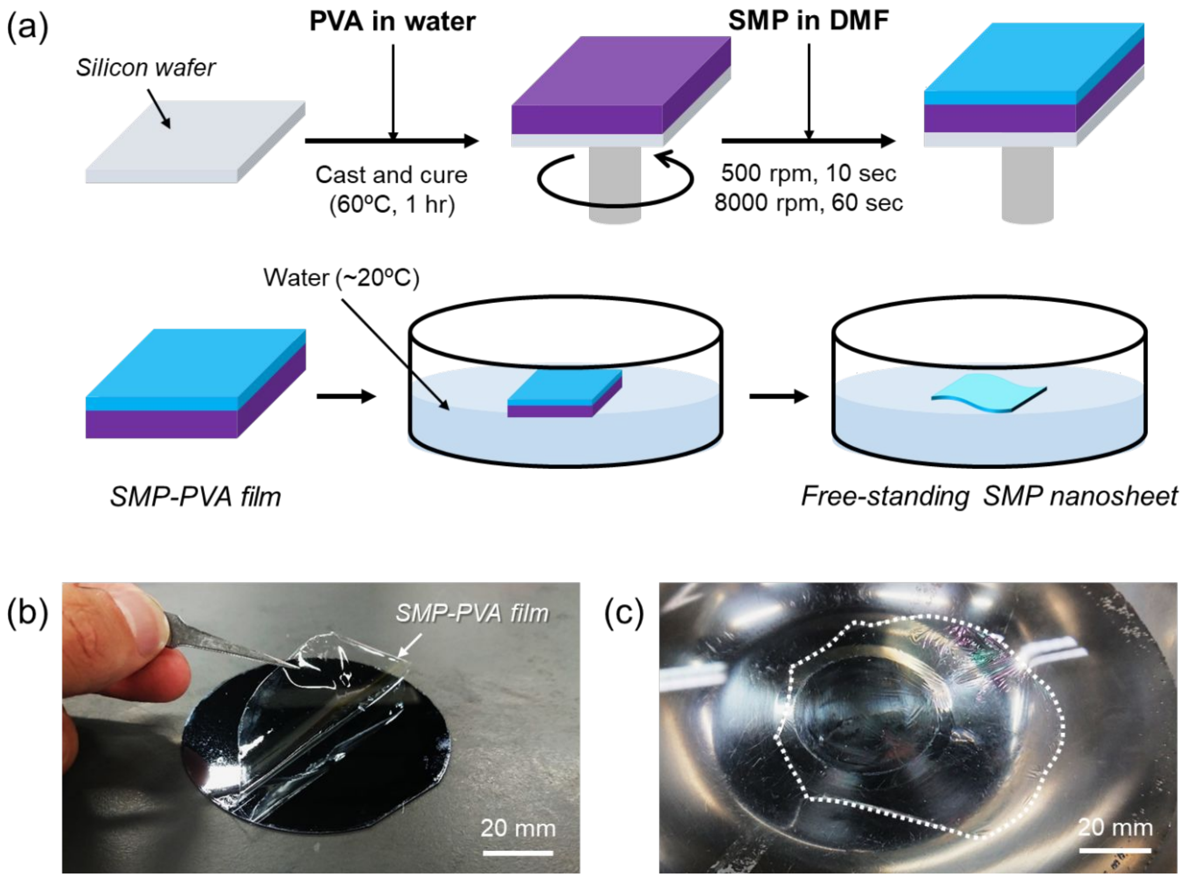

Figure S3. (a) Schematic illustration of the procedure to fabricate free-standing SMP micro/nanosheets by a water-soluble supporting layer method. (b) Image of an SMP-PVA bilayered film being peeled off from a 3“silicon wafer with a tweezer. (c) Image of a free-standing SMP nanosheet with the size of 3“silicon wafer floating on water.

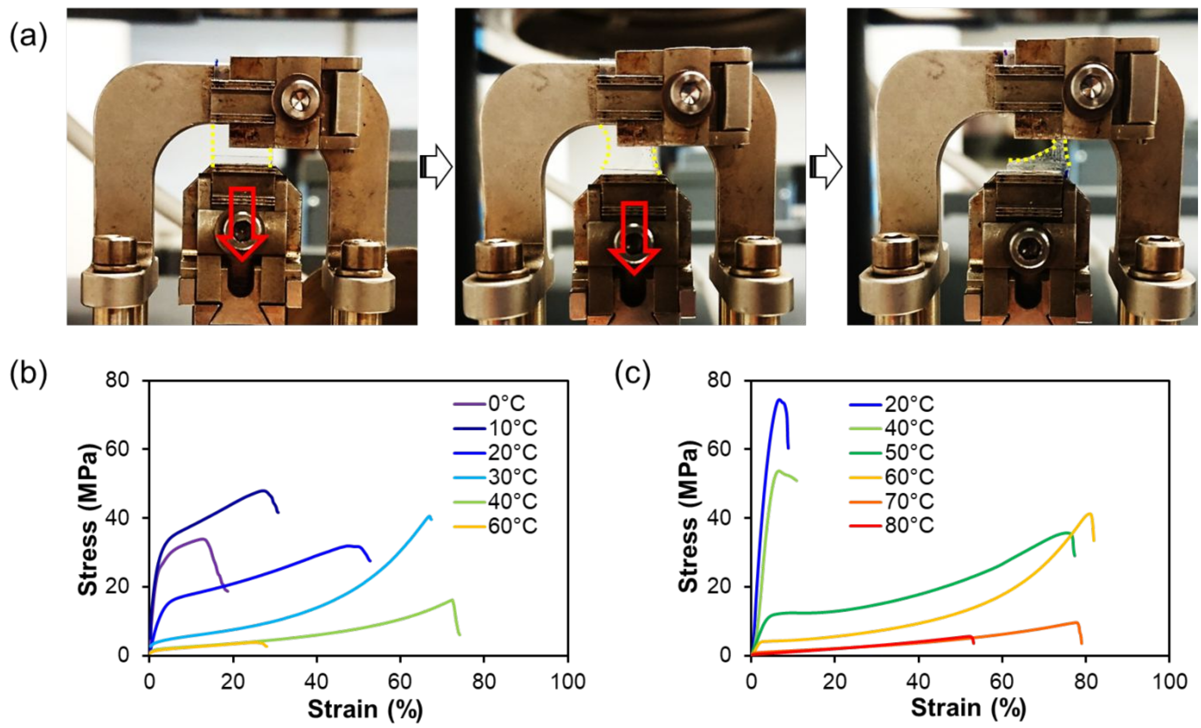

Figure S4. Tensile test for SMP microsheets. (a) Images of an SMP microsheet fixed to a tensile testing machine before being stretched (left), during being stretched (middle), and after being torn (right). Yellow dashed lines represent the contours of the SMP microsheets. Red arrows represent the direction of tensile force. (b) Stress-strain relationship of an SMP microsheet with the T_g of 25˚C at different temperatures (0 – 60˚C). (c) Stress-strain relationship of an SMP microsheet with the T_g of 55˚C at different temperatures (20 – 80˚C).

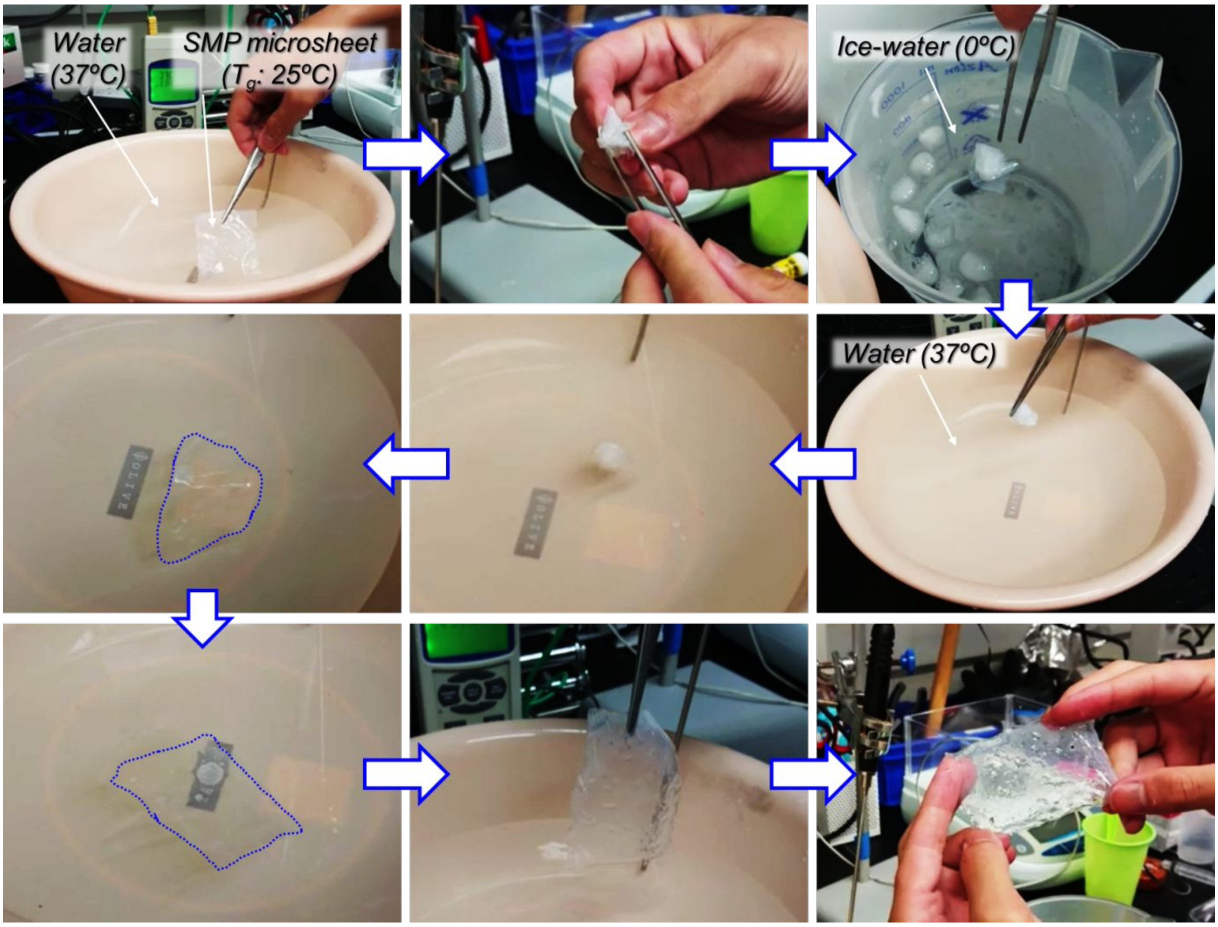

Figure S5. Self-expandability of an SMP microsheet. An SMP microsheet with the T_g of 25˚C was crumpled just after immersed in 37˚C water (left and middle of top row). Once the crumpled sheet was immersed in 0˚C ice water (a lower temperature than the T_g), the shape was temporarily fixed (right of top row). When the crumpled sheet was immersed in 37˚C again, the sheet spontaneouly expanded without any external force because of SME; the SMP microsheet memorized the flat state (from right of middle row to right of bottom row).

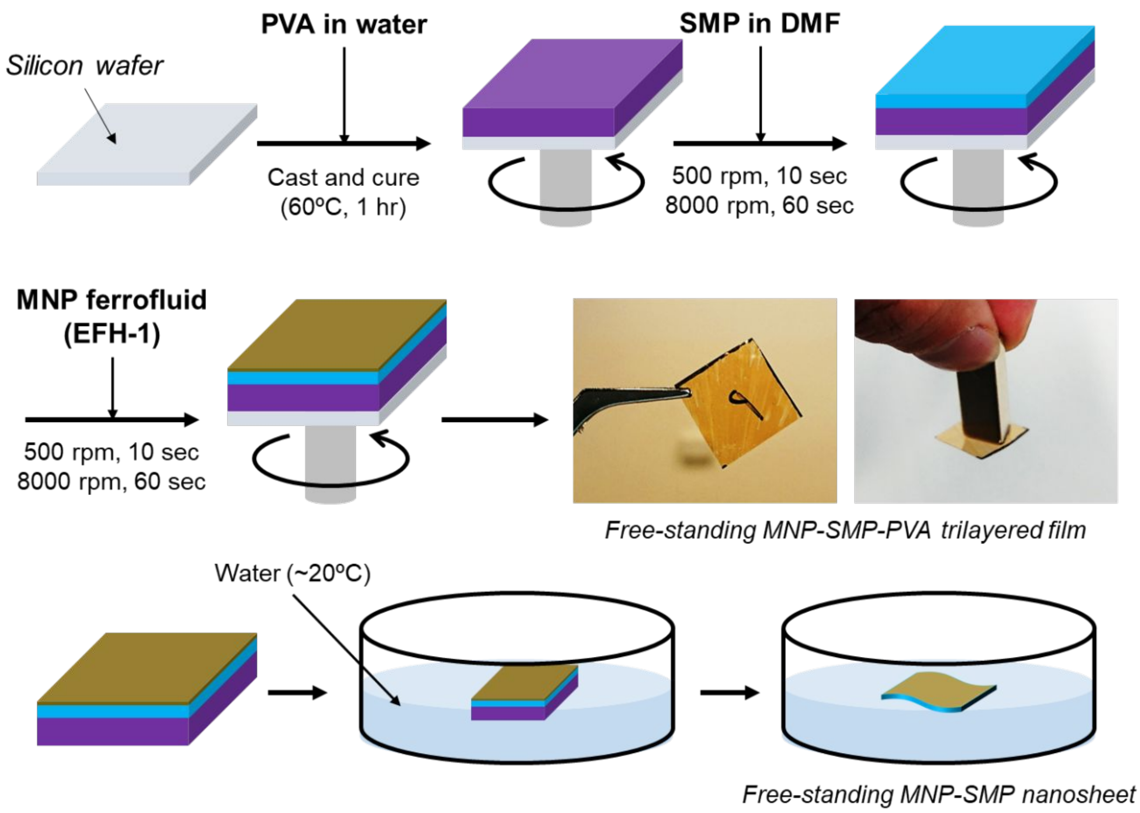

Figure S6. Schematic illustration of the procedure for fabricating free-standing MNP-SMP nanosheets by a water-soluble supporting layer method. EFH-1 is a commericially available ferrofluid containing superparamagnetic iron oxide nanoparticles. Left image: A free-standing MNP-SMP-PVA trilayered film being held by a tweezer. Right image: An MNP-SMP-PVA trilayered film being lifted by a neodymium magnet.

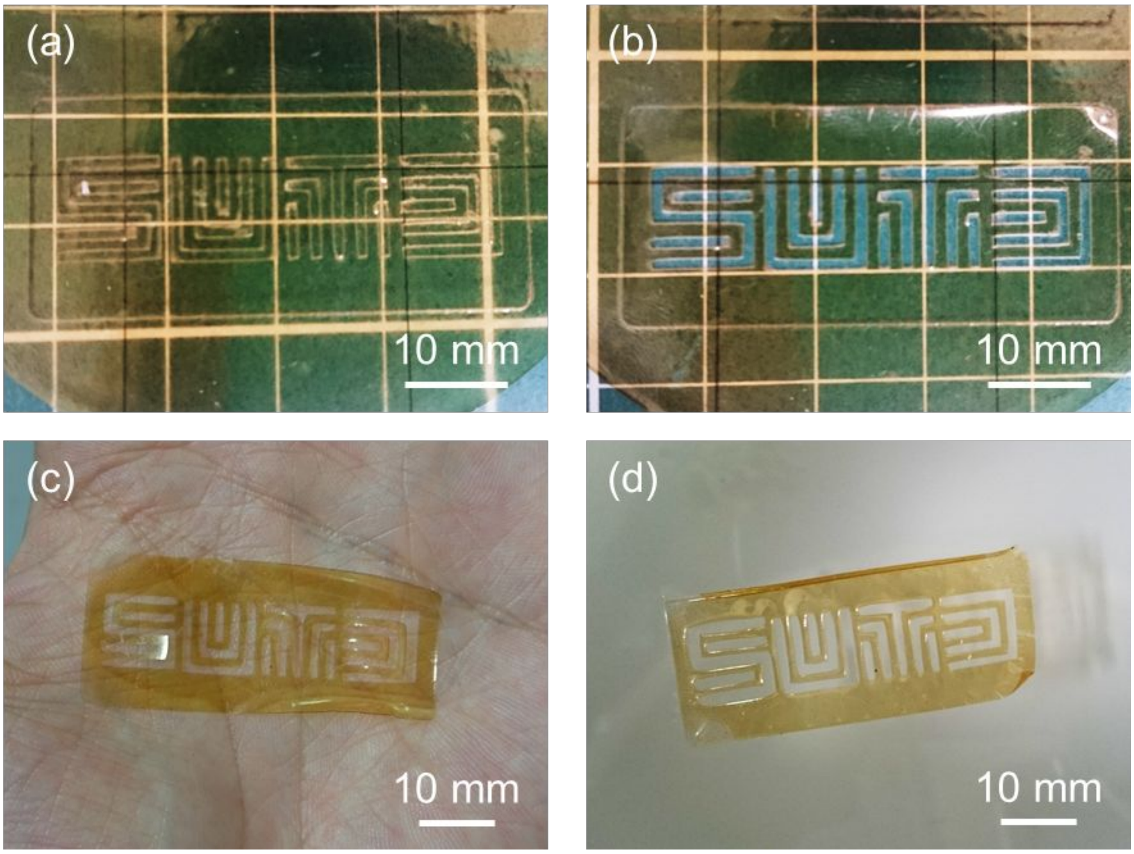

Figure S7. Fabrication of an MNP-SMP nanosheet with well-defined patterns. (a) Image of an MNP-SMP-PVA trilayerd film with the institution logo created by a cutting plotter. (b) Image of an MNP-SMP-PVA trilayerd film with the institution logo (i.e. SUTD, © Singapore University of Technology and Design) after the removal of the area of the logo pattern. (c) Image of a free-standing MNP-SMP-PVA trilayerd film with the logo on the hand. (d) Image of a free-standing MNP-SMP nanosheet with the logo floating on the water after dissolving the PVA layer.

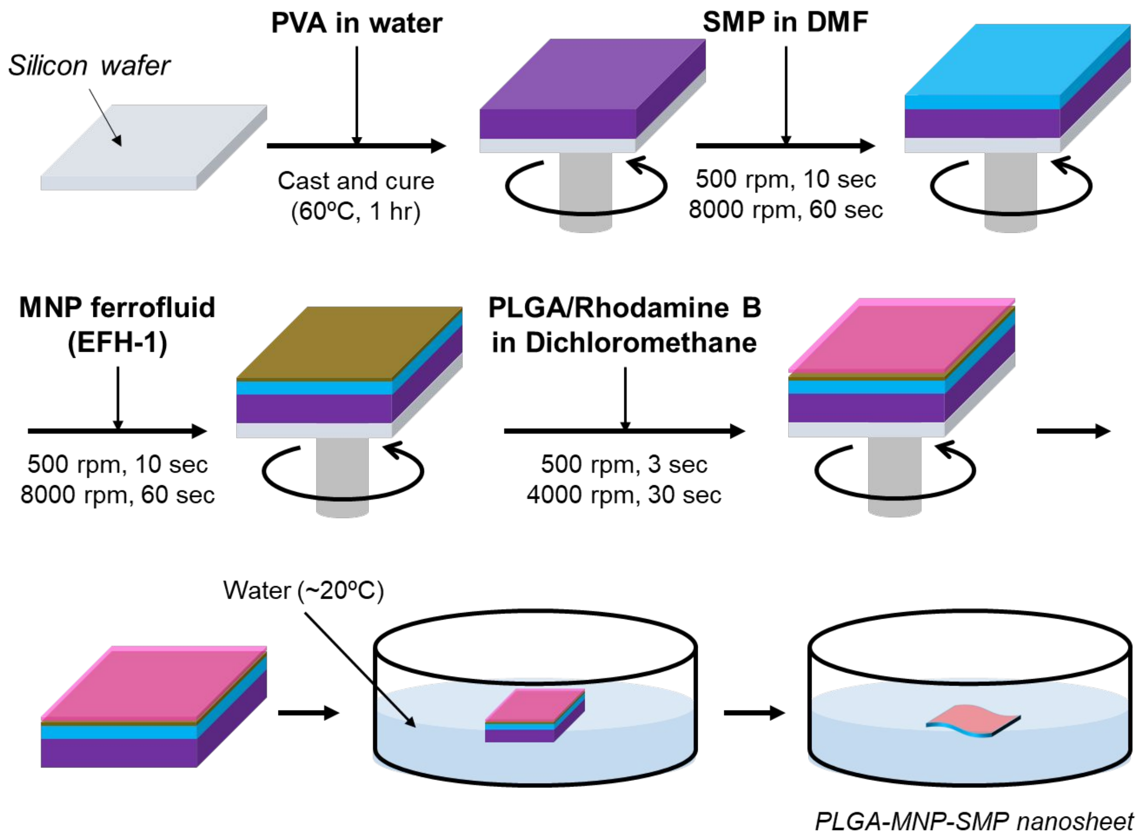

Figure S8. Schematic illustration of the procedure to fabricate free-standing PLGA-MNP-SMP nanosheets by a water-soluble supporting layer method.

Legends of Movies S1-S6:

Movie S1. Tissue-adhesive property of an MNP-SMP nanosheet. The MNP-SMP nanosheet adhering to the surface of chicken muscle was not detached nor dislocated even the chicken was vigorously shaken.

Movie S2. An SMP-PVA bilayered film with the size of 3" silicon wafer was released in water to dissolve the PVA layer.

Movie S3. Self-expandability of an SMP microsheet. An SMP microsheet with the T_g of 25˚C could be crumpled just after immersed in 37˚C water. Once the crumpled sheet was immersed in 0˚C ice water that is a lower temperature than the T_g, the shape is temporarily fixed. When the crumpled sheet was immersed in 37˚C again, the sheet was expanded by itself without any external force because the shape of the SMP microsheet is memorized as a flat sheet.

Movie S4. Syringe-injectability and self-expandability of an MNP-SMP nanosheet. When ejected into the water at 37˚C, the MNP-SMP nanosheet was self-expanded to the original flat sheet immediately without losing its integrity.

Movie S5. An MNP-SMP nanosheet was not expanded but maintained as a crumpled structure when ejected into the ice water at 0˚C.

Movie S6. Magnetic gidability of an MNP-SMP nanosheet. The location of the MNP-SMP nanosheets floating in 37˚C water was controlled by the neodymium magnet at the distance of ~1 cm from the sheet.