Supporting Information

Dynamic Optical Gratings Accessed by Reversible Shape Memory

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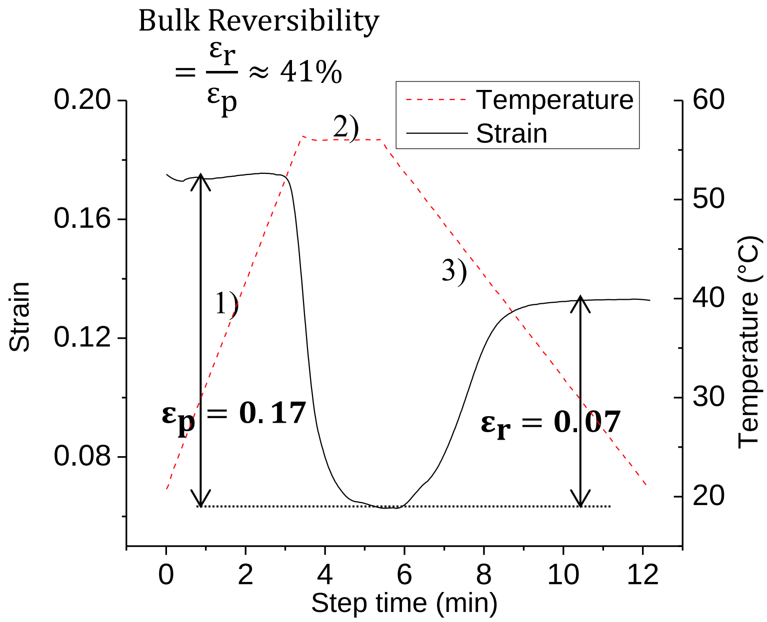

Figure S1. A dogbone bulk sample's maximum reversibility was characterized by DMA tensile test as 41%, where ε_p was defined as programmed strain and ε_r as recovered strain. Partial melting temperature Tp was near Tm = 56 °C. The temperature ramp has similar rate as the optical experimental set up: 1) Heat from 20 °C to 56 °C (10 °C/min); 2) Wait 2 min at 56 °C; 3) Cool from 54 °C to 20 °C (5 °C/min).

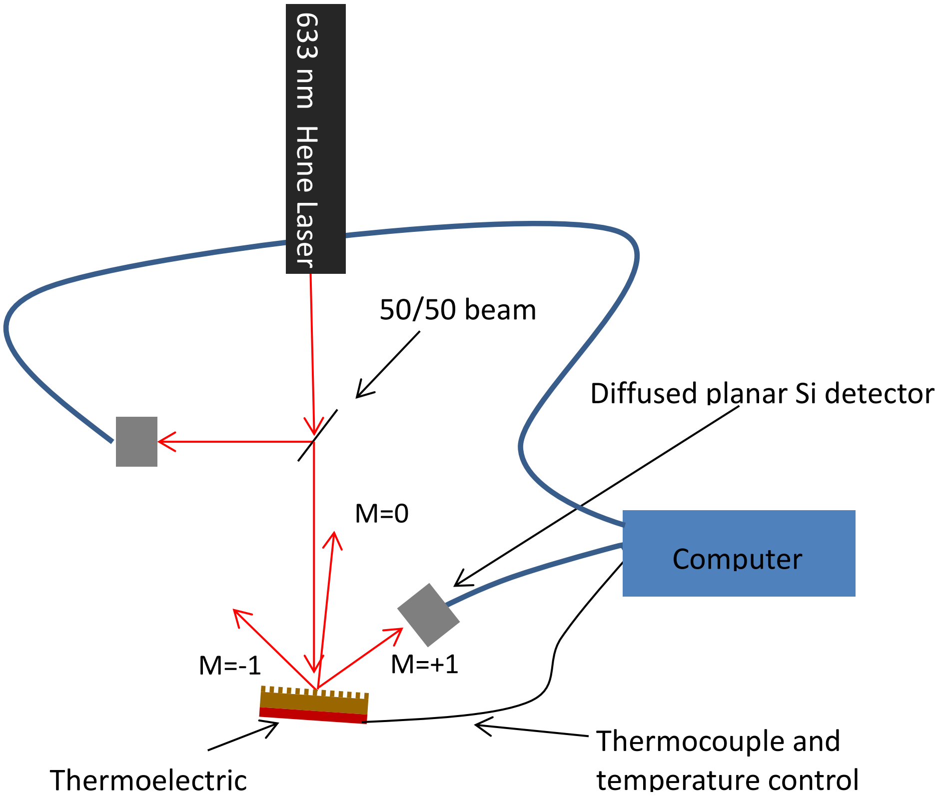

Figure S2. Optical measurement set up, for measuring the diffraction intensity. The incident beam is first, passed through a 50/50 beam splitter, in order to monitor the incident power. The beam then impinges on the surface of the SMP grating. The resultant first order diffraction intensity is monitored via a diffused planar Si detector. The SMP grating is placed in contact with the thermoelectric stage and the temperature of the sample was controlled via Labview and monitored with a thermocouple.

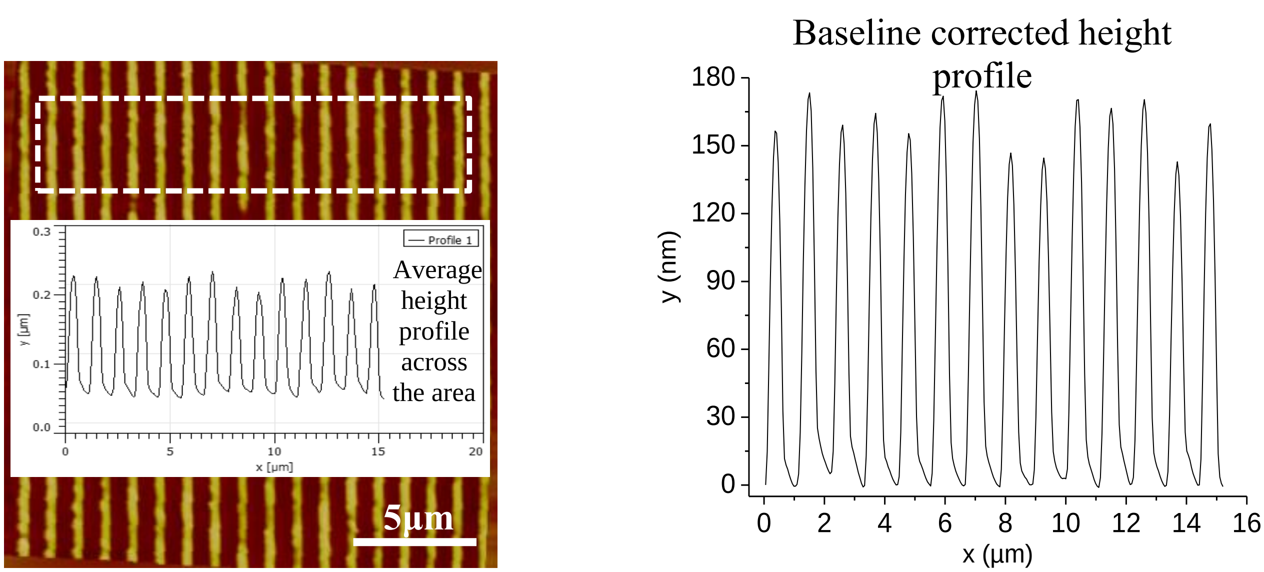

Figure S3. AFM height analysis of grating topology. A cross-sectional area was chosen to be averaged and from this area 180 line profiles are averaged to compile the averaged line profile. The averaged line profile is then baseline corrected and the average ridge height is calculate

(a) (b)

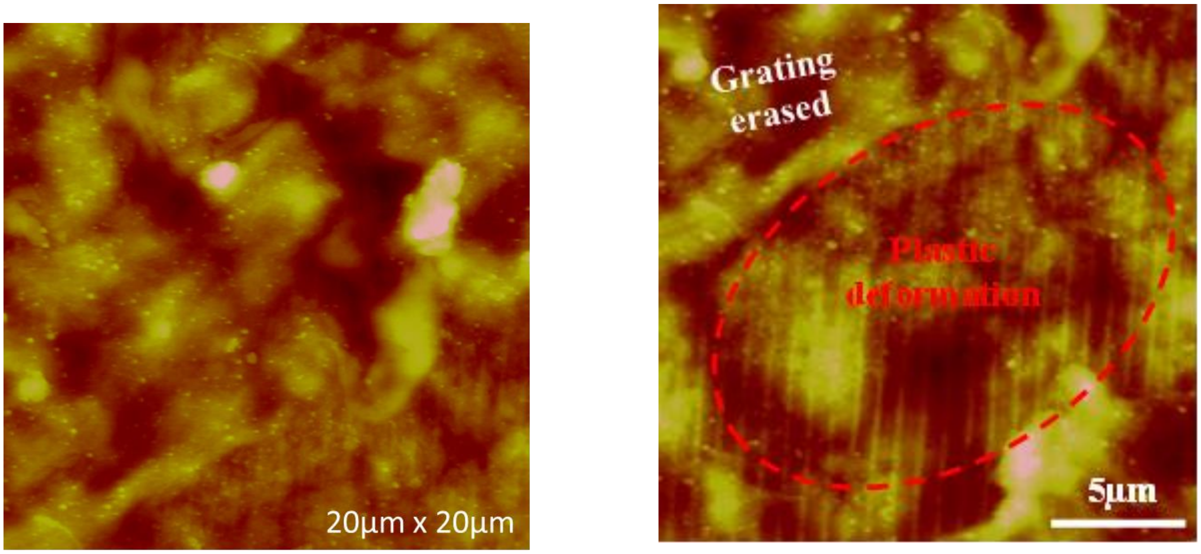

Figure S4. An SMP piece was heated to 80°C, a complete melting temperature, then cooled back to RT. Most gratings structures were erased and surface returned to the original shape **(a)**, however a few spots turned out to remain grating structure due to plastic deformation **(b)**. The crystallization induced random roughness on the erased area was also observed.

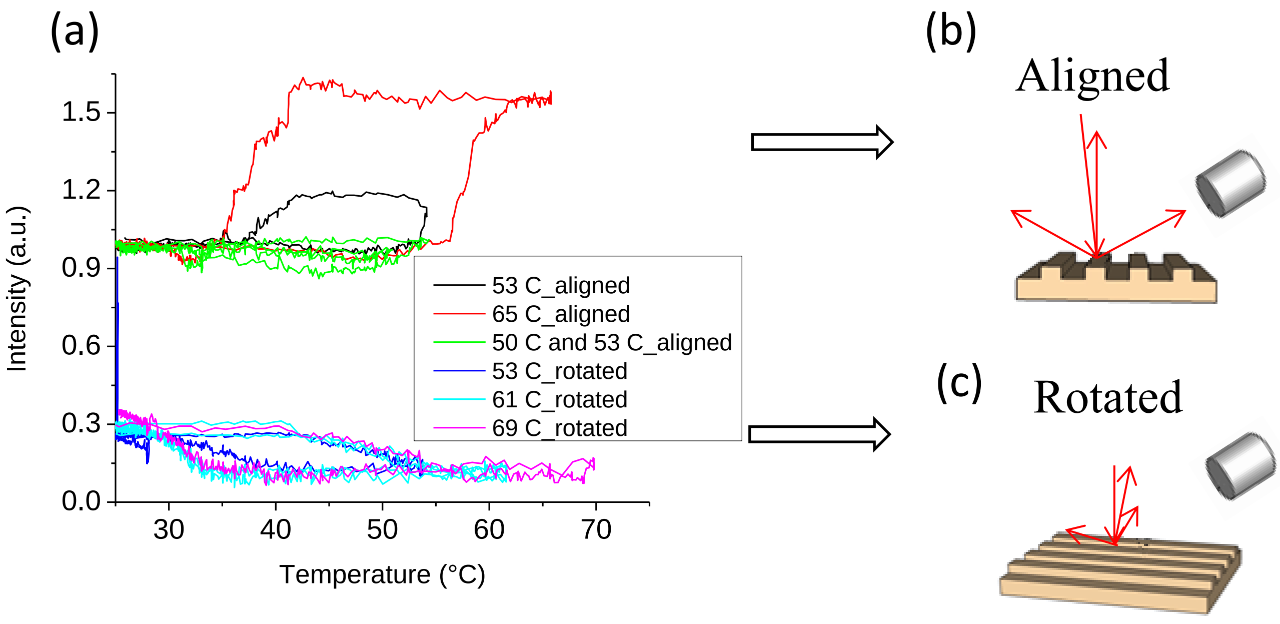

Figure S5. Optical measurements **(a)** of a permanent grating, with no programed secondary memory. When the 1^{st} diffraction order is **(b)** aligned with the detector and the temperature is varied, the permanent grating undergoes an internal realignment as the crystals melt which smoothes the grating surface. This results in a more efficient grating, increasing the observed intensity. The permanent grating is then rotated 90° **(c)** and the detector only picks up scattered light as the grating is cycled. In this measurement the modulation in intensity is due to the crystallites melting and recrystallization during cycling.

In this study a permanent grating with no secondary memory is cycled to determine the contribution of scattered light while a grating remains. A SMP prepolymer mixture was poured into a Teflon flat mold with a PFPE replica of the silicon grating placed on the bottom of the mold. After UV curing, the bottom side of the sample has permanent grating structure. Measurements of a permeant shape grating, with no programmed secondary memory, were performed in order to determine the difference in the intensity of scattered light versus diffracted light while a grating is present. The SMP permanent grating was first aligned with the silicon detector and cycled through various temperatures below and above T_m. Bellow T_m there is almost no change in the intensity of the diffraction spot however at Tm and above T_m there is an increase in intensity which can be attributed to a majority of crystallites melting and the grating returning to its as molded, perfectly ordered, shape. When the sample is rotated 90 degrees and the detector only detects scattered light, the intensity drops and a modulations of ~10% is seen for scattered light at T_m. It can be observed that while a grating is present on the sample surface, any intensity modulation observed is due mainly to shape shifting of the grating and not scattering from crystal melting and recrystallization.

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