<Supplementary Information>

Strong Molecular Weight Effects of Gate-Insulating Memory Polymers in Low-Voltage Organic Nonvolatile Memory Transistors with Outstanding Retention Characteristics

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This supporting information contains following data:

Table S1 Summary of device performances according to the PVA molecular weight.
Figure S1 Photographs (top-view) of the PVA layers (250 nm).
Figure S2 Transfer curves (V_D = -1 V) of the PVA-TOMDs for the two representative PVA molecular weights.
Figure S3 Auger electron microscope (AEI) images (atom: oxygen) for the PVA layers.
Figure S4 Direct comparison of 1D GIXD profiles for the PVA layers.
Figure S5 Replotted graphs by adjusting the drain current scale in Figure 8.
Figure S6. Retention (WRER) characteristics for the PVA-TOMDs (all four molecular weights)
Figure S7. Retention time characteristics for the PVA-TOMDs (ON/OFF states)
Table S1. Summary of device performances according to the PVA molecular weight. Note that the hole mobility ($\mu_h$) was calculated using $I_D = \frac{W}{2L} \mu_h C_i [(V_G - V_{TH})^2]$ in a saturation regime ($|V_G - V_{TH}| < |V_D|$).

| PVA Molecular Weight | 9.5 kDa | 40.5 kDa | 93.5 kDa | 166.0 kDa |
|----------------------|---------|---------|---------|---------|
| $\mu_{h,F}$ @ $V_D = -5V$ | 44.2 | 66.6 | 3.8 | 3.7 |
| (10$^{-3}$ cm$^2$/Vs) | | | | |
| $\mu_{h,B}$ @ $V_D = -5V$ | 8.7 | 11.9 | 1.44 | 0.9 |
| (10$^{-3}$ cm$^2$/Vs) | | | | |
| ON/OFF Ratio @ $V_D = -5V$ | 3.2 | 6.0 | 1.4 | 0.3 |
| ($x10^5$) | | | | |

Memory Window

| $\Delta V_{TH}$ @ $V_D = -1V$ (V) | 4.7 | 3.4 | 3.3 | 3.2 |

$\Delta I_D$ @ $V_G = V_D = -1V$ (nA)

| 53.0 | 64.0 | 61.0 | 63.4 |

Note) $\mu_{h,F}$ and $\mu_{h,B}$ denote the hole mobility in the forward and backward sweeps, respectively (see Figure 3).
Figure S1. Photographs (top-view) of the PVA layers (250 nm) coated on ITO-glass substrates according to the PVA molecular weight. Note that all samples show optical transparency as the back side letters (KNU) are clearly observed.

Figure S2. Transfer curves ($V_D = -1$ V) of the PVA-TOMDs for the two representative PVA molecular weights. ‘F’ and ‘B’ represent forward (from +5 V to -5 V) and backward (from -5 V to +5 V) sweeps, respectively. Note that the ON current of devices is larger for the low molecular weight PVA (9.5 kDa) than the high molecular weight PVA (166 kDa), even though the OFF current is similar.
Figure S3. Auger electron microscope (AEM) images (atom: oxygen) for the PVA layers coated on ITO-glass substrates: (a) 9.5 kDa and (b) 166.0 kDa.
Figure S4. Direct comparison of 1D GIXD profiles, which are extracted from corresponding 2D images (see Figure 5b inset), for the PVA layers coated on ITO-glass substrates: (a) OOP and (b) IP directions. The intensity ratio of (101) OOP peak to IP peak was 9.11 (9.5 kDa), 7.84 (40.5 kDa), 7.34 (93.5 kDa), and 7.14 (166.0 kDa), which indicates that the higher the PVA molecular weight, the lower the (101) stacking of PVA chains in the OOP direction.
Figure S5. Replotted graphs by adjusting the drain current scale in Figure 8 for better comparison of the writing-once-reading-many (WORM) operation results according to the PVA molecular weight. The writing (W) operation was performed at $V_G = -5$ V and $V_D = -2$ V, while the reading (R1~R8) operation was performed at $V_G = -1$ V and $V_D = -2$ V.
Figure S6. Retention characteristics for the PVA-TOMDs by applying continuous writing-reading-erasing-reading (WRER) cycles: W (writing) at \( V_G = -5 \) V \( \rightarrow \) R1 (reading) at \( V_G = -1 \) V \( \rightarrow \) E (erasing) at \( V_G = +5 \) V \( \rightarrow \) R2 (reading at \( V_G = -1 \) V). Note that the drain voltage was fixed at \( V_D = -2 \) V for the entire measurement (10000 cycles). The PVA molecular weight: (a) 9.5 kDa, (b) 40.5 kDa, (c) 93.5 kDa, and (d) 166 kDa.
Figure S7. Retention time characteristics for the PVA-TOMDs after turning on (a) by writing at $V_G = -5$ V and turning off (b) by erasing at $V_G = +5$ V: (a) ON-state continuous reading at $V_G = -1$ V; (b) OFF-state continuous reading at $V_G = -1$ V. The PVA molecular weight is given directly on each plot. Note that the better retention (time) stability was measured for the device with the higher molecular weight of PVA.