Electronic Supplementary Material (ESI) for Nanoscale.

Supplementary Information

Ag_2S atomic switch-based 'Tug Of War' for decision making

C. Lutz[a,b], T. Hasegawa[a], T. Chikyow[b]

[a]Waseda University, 3-4-1 Okubo, Shinjuku, Tokyo, 169-8555 Japan
[b]NIMS MANA, 1-1 Namiki, Tsukuba, Ibaraki, 305-0044 Japan

1. Sulfurisation of the Ag electrodes with isolation layer.

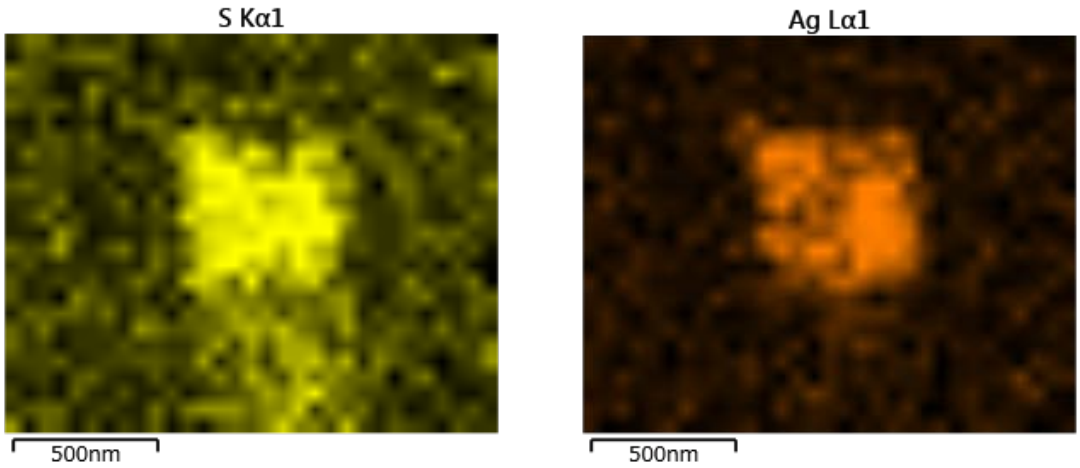

Fig. S1. EDS data: Continuous layer of Ag_2S for small electrodes; S around electrode due to thiophene containing polymer on sample.

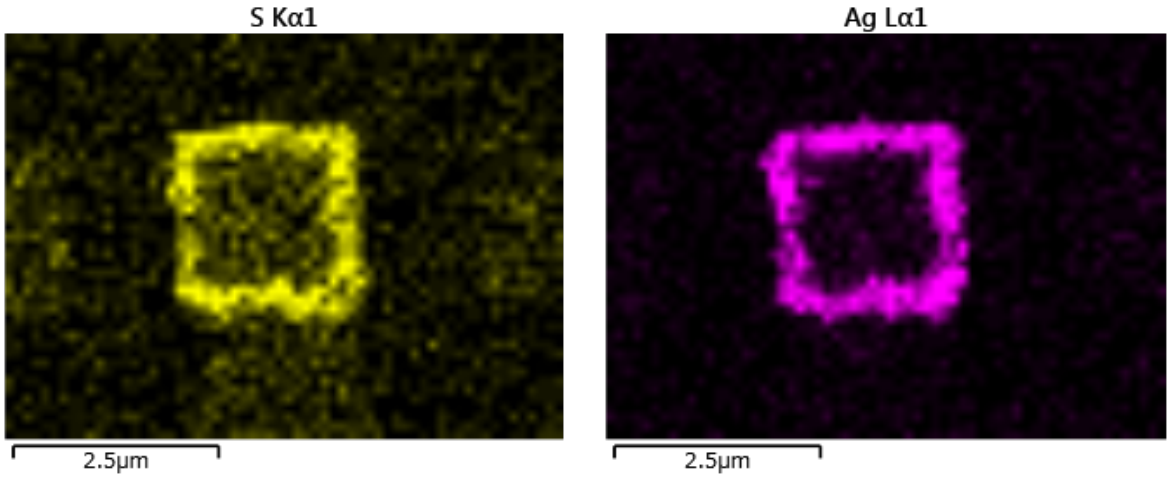

Fig. S2. For larger electrodes, Ag was moved away of original position during sulfurisation, resulting in a continuous border of Ag_2S around the electrodes. Complete areal overlap of the signals from Ag and S indicates that all Ag was sulfurised.

2. Crystal phase of sulfurised Ag, α or β-Ag_2S?

Tanaka et al. reported that only β-Ag_2S can grow filaments (e-J. Surf. Sci. Nanotech., 2014, 12, 185). But β-Ag_2S is reported not to be stable at room temperature (Econ. Geol. 1959, 54, 1278). We sulfurised a sample fully covered with Ag, checked if it can grow filaments with SEM and which crystal structure it has with XRD. The results suggest that α-Ag_2S can also grow filaments.

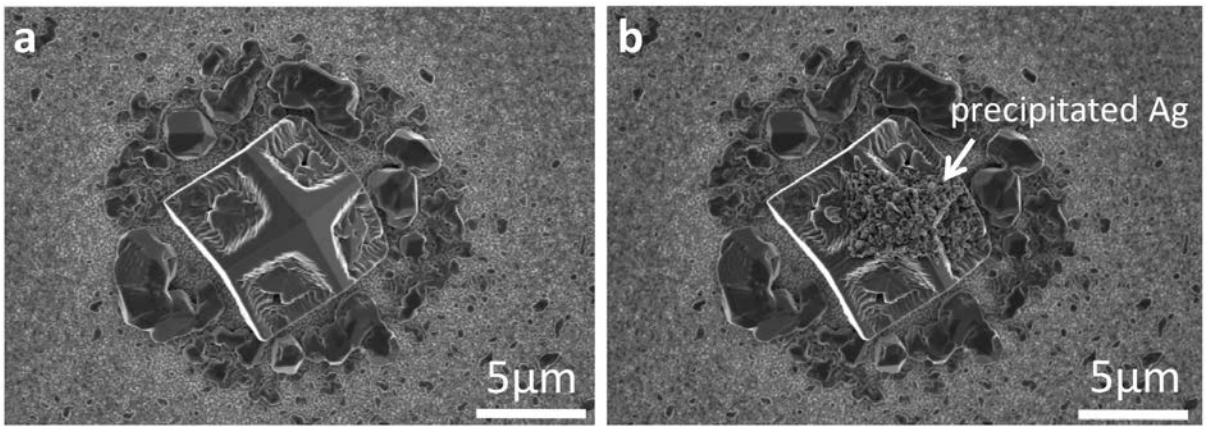

Fig. S3. The whole surface of the sulfurised Ag-layer is covered with Ag_2S crystals. a): A large Ag_2S crystal. b): SEM observation caused Ag precipitation on the surface of the large Ag_2S crystals, when magnification was increased in the meanwhile of image a) and b).

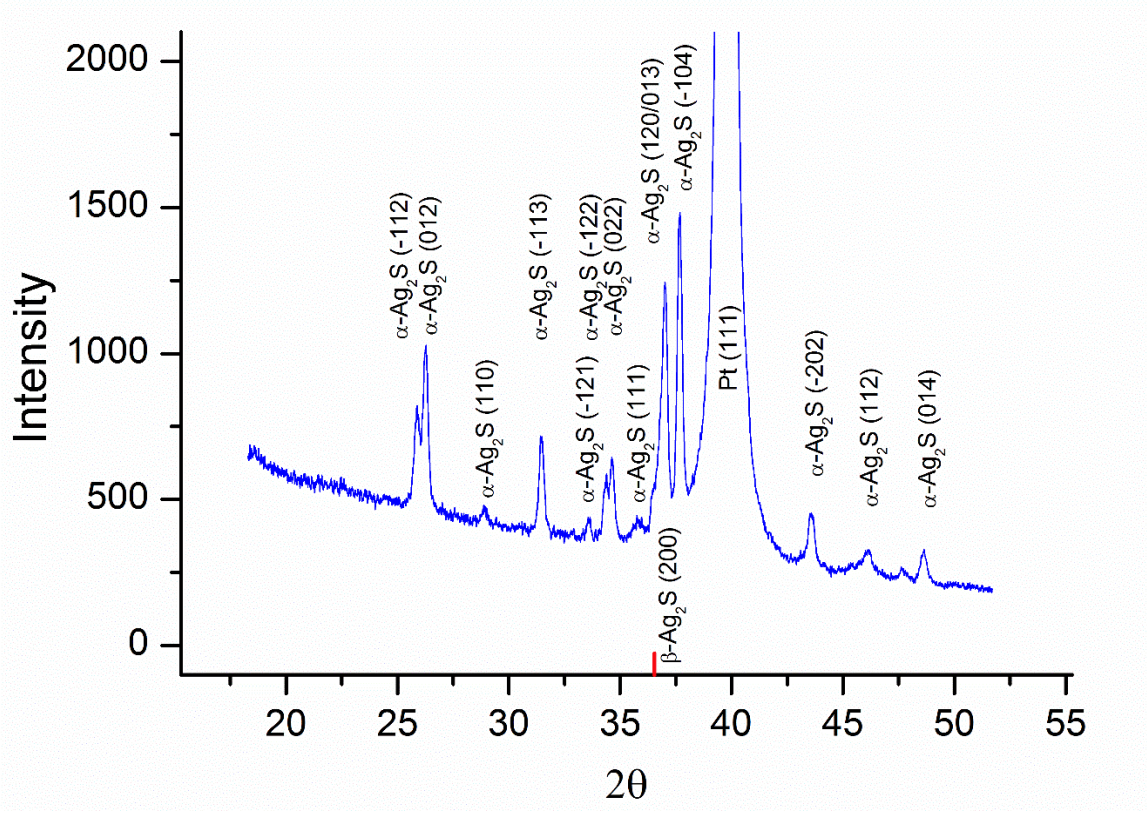

Fig. S4. XRD data for the Ag_2S film formed by the same process used for the device fabrication. Observed peaks indicate that the Ag_2S is in α-phase.

3. Disconnection and connection during IV-measurements

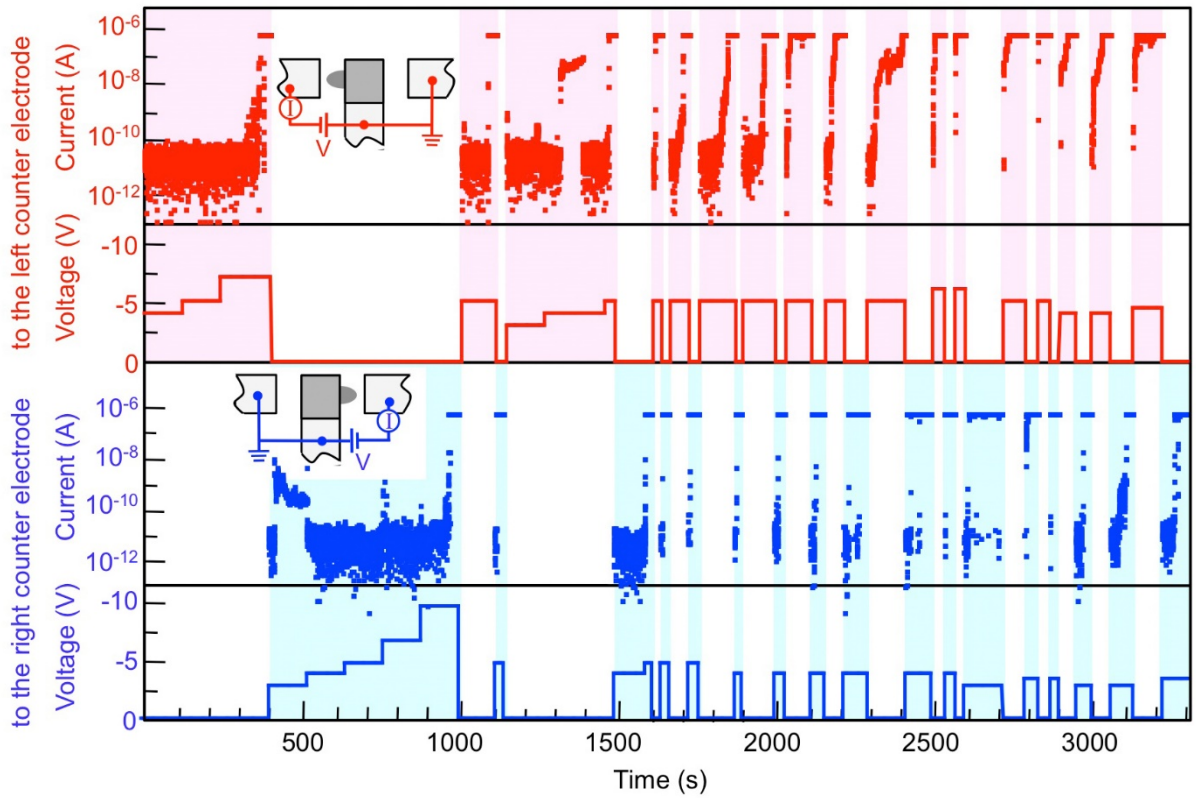

Fig. S5. Same data as in Figure 4 of the main manuscript with log scale for the current. It can be seen that the current always started in the range of pA, showing that the connections were broken before being re-established.

Additional IV-measurements to confirm the breakage of a prior connection, when a new connection to the opposite side is established. For this purpose, a small read voltage was applied to the side of the prior connection, while a larger bias voltage was applied to the opposite counter electrode in order to cause filament growths in this direction.

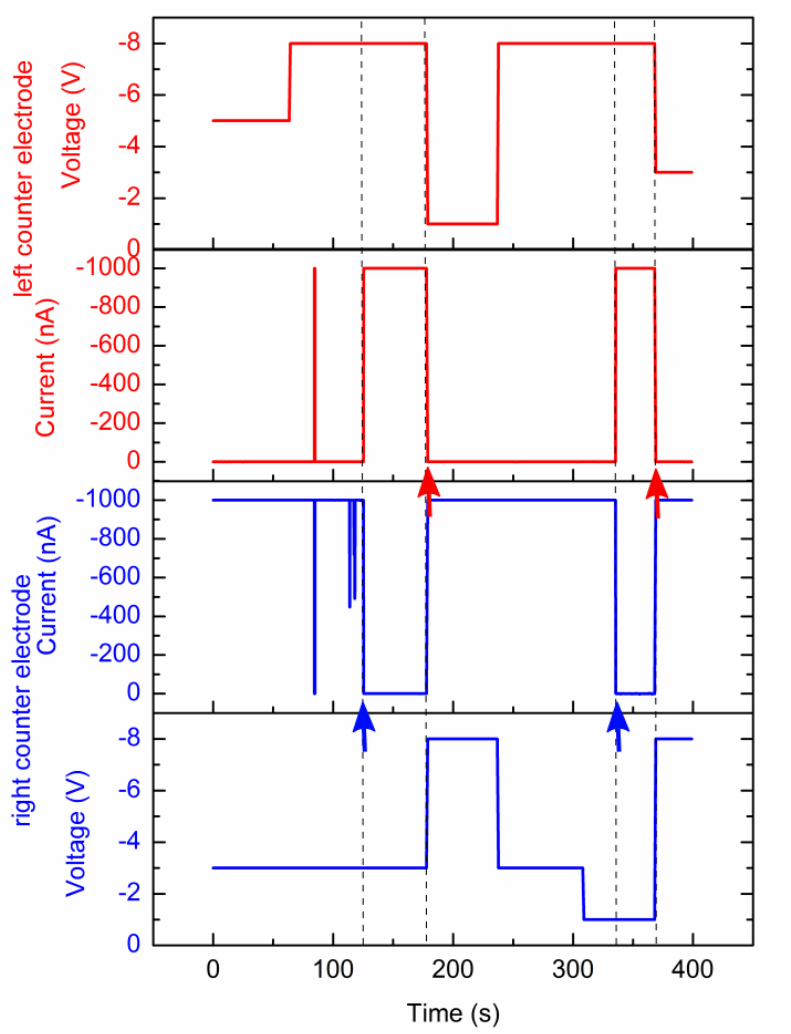

Fig. S6. Disconnection induced by establishment of connection to the opposite side. All of the four disconnections, indicated by arrows, occurred at the exact moment when connection to the other side was established. For example, the disconnections indicated by blue arrows occurred when the connection to the left counter electrode was established. At this time, the bias voltage applied to the right counter electrode was constant and smaller than the bias to the left counter electrode.