A fast operation of nanometer–scale metallic memristors: highly transparent conductance channels in Ag_2S devices

Miklós Csontos, Ágnes Gubicza, Attila Geresdi, András Halbritter, György Mihály

Department of Physics, Budapest University of Technology and Economics, Budafoki ut 8, 1111 Budapest, Hungary

csontos@dept.phy.bme.hu

Abstract

Since the pioneering experiments reported on Ag-Ag_2S-Pt memristor junctions [1] the development of memory cells based on memristive systems has achieved a remarkable progress. The results are extremely promising for the short term realization of highly integrated information storage applications [2]. However, due to fundamental RC limitations in the presence of the large OFF state resistances, the best performing Ag_2S devices were operated up to ~10 MHz frequencies so far. Here we demonstrate a proof-of-principle memory cell which is both small (close to atomic sizes) and fast (GHz operation) [3].

We studied the resistive switching of Ag–Ag_2S–Me memristive nanojunction devices. We showed that by suitable sample preparation reproducible resistive switching and readout can be performed where both the ON and OFF states are metallic, characterized by technologically optimal 100 – 1000 Ω resistances and similar device functionalities down to cryogenic temperatures. We introduced point contact Andreev reflection spectroscopy to determine the size and transmission probabilities of the active volume of the devices which revealed a small number of highly transmitting nanoscale conducting channels with reduced but not completely dissolved junction area in the OFF state. The relatively low resistance ON and OFF states enable fast operation: our devices can be switched by nanosecond voltage pulses at room temperature. The achieved R_{OFF}/R_{ON} ratios of 2 – 10 satisfy the basic requirement of reliable read-out. These results indicate that Ag_2S represents a promising material basis for a future generation of high speed resistive switching memory devices overriding the downscaling limitations of current CMOS technology.

References

[1] K. Terabe at al., Nature **433** (2005) 47.
[2] J.J. Yang et al., Nature Nanotechnology, **8**, (2013) 13.
[3] A. Geresdi, M. Csontos, A. Gubicza, A. Halbritter, G. Mihály, Nanoscale, **6** (2014) 2613.

Figures

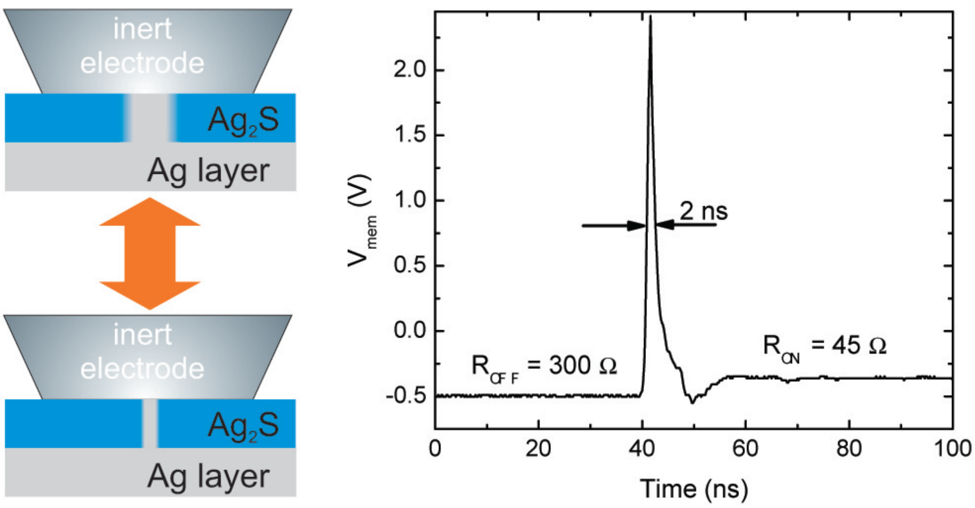

Fig.1 Resistive switching taking place at nanosecond timescales in the Ag_2S layer are attributed to a change in the diameter of the metallic conducting channel.