Bio-resorbable memristor with alginate as an active layer for transient electronics

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Bio-resorbable and transient electronics that imply chemically or physically dissolution after a certain period operation have drawn considerable attention due to the demand of biocompatibility for eco-friendly applications [1]. This work presents alginate-based resistive random-access memory (RRAM) to establish bio-resorbable memristive system. Alginate is assumed as the switching layer by using solution process and prove its bipolar switching behavior, which refers we can apply set/reset operations in small ranges(-2V~3V) of voltage to enhance power consumption efficiency. High stability was also verified by endurance and retention time due to tolerance and long-term maintenance. Bio-resorbable properties of RRAMs, which were fabricated with water-soluble Mg electrodes was investigated by fully dissolving in DI water and dissolving time controllability was also demonstrated by modulating the thickness of Al_2O_3 capping layer, which was deposited using atomic layer deposition(ALD). With this approach, it is expected that biocompatible RRAMs can apply to a neuromorphic system by fitting two terminal devices which have closely characterized structures with artificial synapses [2]. Controlling the dissolving time, we can also consider of the hardware-security. Furthermore, the devices have implantable characteristics in human-body so it can be used in the area of medical surgery or health-care problems.

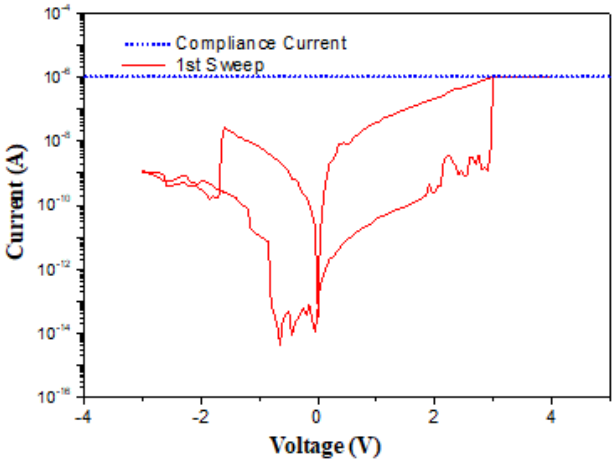

Fig. Set and reset of bio-resorbable alginate memristor devices

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References

[1] Min-Kyu Song, Seok Daniel Namgung, Young-Woong Song, Taehoon Sung, Wonjae Ji, Yoon-Sik Lee, Ki Tae Nam, Jang-Yeon Kwon, ACS Appl. Electron. Mater. 2021, 3, 3372

[2] Aristide Gumyusenge, Armantas Melianas, Scott T. Keene, Alberto Salleo, Annu. Rev. Mater. Res. 2021. 51:47–71

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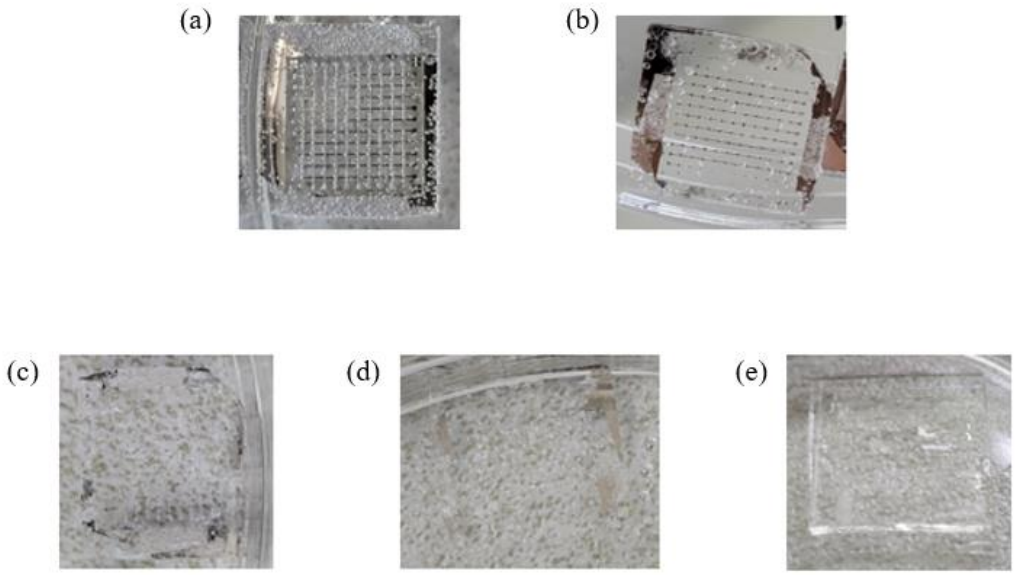
Supplementary Pages (Optional)



Supporting Figure S1. Solubility test for Mg electrode with Al_2O_3 capping layer in DI water according to time. Each image indicates 10 minutes (a), 1 hour (b), 3 hours (c), 4 hours (d), and 6 hours (e) after pouring DI water on device