The chemical state analysis of Al/Fe_3O_4 interfaces using synchrotron radiation photoemission spectroscopy

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There has been a growing demand for high-performance memory devices made of common metals so as to reduce environmental burdens and ensure a sustainable supply of devices. The resistance random access memory (ReRAM) is one of the promising candidates for the purpose. Since the bipolar resistive switching may occur through the interfacial redox reaction between metal electrodes and transition metal oxides [1], the ReRAM devices that consist only of materials with high Clarke number can be fabricated by controlling the interfacial redox reaction. In this study, we have focused on the interface between Al electrodes and magnetites (Fe_3O_4) that is made of high Clarke number elements, and characterized the device performance. Furthermore, the interfacial chemical states were also investigated by *in-situ* synchrotron radiation photoemission spectroscopy (SRPES). Two types of Al/Fe_3O_4 device structures have been fabricated: one is the stacked structure of the Al electrode on as-received Fe_3O_4 substrates without any surface treatments, and the other is the stacked structure of the Al electrode deposited *in-situ* on the Fe_3O_4 films which are grown on MgO substrates by PLD. The former showed the typical bipolar resistive switching, while the latter exhibited the ohmic behavior. The detailed analyses of SRPES results are shown in Fig.1. There was a significant difference in interfacial chemical states between the two devices, reflecting the difference in the chemical states at the surface before Al deposition. These results suggest that appropriate fabrication processes for controlling interfacial layers between Al electrodes and Fe_3O_4 are the key to the development of the environmentally friendly memory devices with high performance.

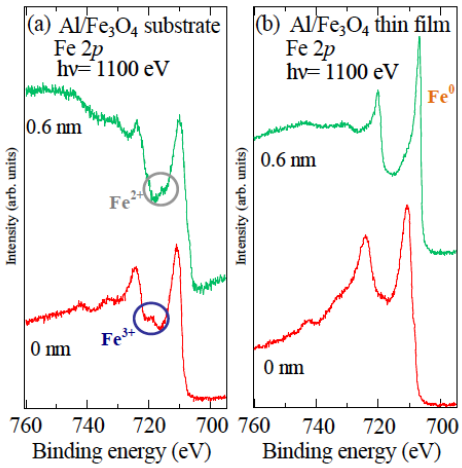

Fig.1. Al layer dependence of Fe 2*p* PES spectra for (a) Al/Fe_3O_4 substrates and (b) Al/Fe_3O_4 thin films

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