Influence of the tip material on the formation and resistive switching properties of NiO naondots

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Resistive switching (RS) consists in changing the resistance state (low resistance state, LRS to High resistance state, HRS or inversely) of a device through the application of an external voltage or current.[1] It has been suggested that the interface effects between electrodes and thin film are critical parameters for understanding the RS behavior.[2] Most of RS behaviors have been studied extensively in thin films with various electrode materials. Few studies on RS behaviors in nanodots have been reported so far. Since the AFM probe can also be used as the top electrode, effects of the electrode material can also be studied. Au and Co-coated tips are used to study material effects on the formation of NiO nanodots. The formation results showed a large dependence on the tip material in the formation of NiO nanodots. Under sufficient humidity, the tip material dependence on the formation of nanodots seems to indicate that the interface effect between the tip and sample surface could be a more important parameter than other parameters. It could be related to the change of the end-shape of the tip during electric field application. The end-shape of the tip may also resultin different magnitude of induced electric field between tip and sample surface. NiO nanodots we have grown show bipolar resistive switching characteristics, but the detailes analysis of electrical transport properties show a behavior that was very different depending on the tip material. Moreover, HRS/LRS ratio (on/off ratio) of the tips is different under positive bias, while the ratio is similar under negative bias. The tip material dependence of RS properties could be described by work function and oxygen affinity. Since the oxygen affinity of Co is large, a cobalt oxide layer could be formed at the surface of the Co tip when positive bias is applied. The electrical current transport mechanism can be explained using I-V fitting with various contact barrier models like the Richadson Schottky Simmons model. My work suggests that it is possible to improve RS characteristic by selecting an appropriate electrode material in nanoscale devices.

References

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