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VO_2/CrO_2-based GMR/TMR Devices Fabrication

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CrO_2 and VO_2 are the two most well-studied rutile oxides due to their potential applications in spin electronic devices and non-volatile memory.[1] CrO_2 is a typical half metal and shows spin polarization of about 98% at low temperatures, making it ideal for Giant Magnetoresistance (GMR) and Tunneling Magnetoresistance (TMR) devices.[2] Bulk VO_2 films present a unique structural transformation and metal-insulator transition (MIT) around 68°C. This makes VO_2 an intriguing barrier layer for unique GMR/TMR heterostructures which behave as a GMR device at low temperature and as a TMR device at high temperature.[3]

The first step for the synthesis of CrO_2/VO_2/CrO_2 heterostructures and GMR/TMR devices is to grow CrO_2 films on TiO_2 substrate with different orientations. Since the growth and properties of CrO_2/TiO_2 (100) and (110) has been studied thoroughly, we mainly investigated the properties of CrO_2 (001) films in our recent work. While CrO_2 (100) are strained film and (110) are unstrained,[4] CrO_2/ TiO_2 (001) films have small strain along "a", "b" and "c" directions. The study of VO_2 thin films grown on (100), (110) and (001)-orientated TiO_2 substrates shows that VO_2 (001) films have lower transition temperature and larger resistance change at MIT compared to (100) and (110) films, which would be a favor for the designed GMR/TMR device. Another key step for the fabrication of GMR/TMR heterostructure is to grow VO_2/CrO_2/TiO_2 bilayer structures and study their properties. Vibrating sample magnetometry shows that the magnetization of CrO_2 film in (110)-orientated bilayer structures is much closer to bulk CrO_2, indicating negligible CrO_2 decomposition at the interface. These results suggest that (110)-orientated TiO_2 is a better choice for the growth of bilayer structures and GMR/TMR heterostructures. The fabrication of GMR/TMR heterostructures and their unique transform properties will be studied in the future.

References

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