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Study on the Growth of Co Films on InP(001)(2×4) Reconstructed Surface

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1. INTRODUCTION

There has been a growing interest in spin injection from a ferromagnet into a semiconductor, ever since S. Datta and B. Dass proposed a possibility of spin transistor [1]. For this purpose, Fe/GaAs hybrid system has been extensively studied [2,3]. But, low spin injection efficiency in this system still remains a problem. Recently, high spin injection efficiency is reported in all semiconducting systems utilizing magnetic semiconductors [4,5]. But, low temperature and large external magnetic field required for operation prevent from practical applications. The present study is motivated to search for a new system applicable to spintronic devices. As a possible candidate, we have studied the Co/InP hybrid system. InP has a direct bandgap energy, which is used in optoelectronic devices for realizing low rectifying contacts [6] While, Co plays an important role in many GMR devices due to the high spin polarization of the carriers at the Fermi level [7]. Therefore, we believe that the study of Co/InP may be interesting from a technological view point. In this study, we have observed not only InP(2×4) reconstructed surface by sputtering-and-annealing, but also growth morphology of Co film on InP(2×4) reconstructed surface using STM .

2. EXPERIMENT

InP substrate of 0.35 mm ×5 mm ×10 mm was cut from undoped n-InP(001) wafer (Wafer Technology Ltd.). The substrate was chemically etched in a solution of H_2SO_4:H_2O_2:H_2O=4:1:1, and rinsed in ethanol using an ultrasonic cleaner. InP sample was mounted on a molybdenum plate and then, inserted into the ultrahigh vacuum (UHV) chamber. During the experiment, the UHV chamber was maintained at a pressure less than 1×10^{-10} Torr. InP sample was sputtered with a 300 eV Ar^+ ion beam and annealed up to 400°C. The (2×4) reconstructed surface of InP was obtained by several cycles of sputtering-and-annealing process. RHEED was used for observing change of structure during each cycle of sputtering-and-annealing. Co was then deposited from a water-cooled e-beam evaporator at a rate of 0.4 ML/min. During the evaporation the pressure was maintained at a value less than 5×10^{-10} Torr. InP(2×4) reconstructed surface and growth morphology of Co film on InP(2×4) surface were investigated using STM. All deposition and measurement were performed at room temperature.

3. RESULTS AND DISCUSSION

Growth morphology of Co film was studied in the thickness range from 0.1 monolayer (ML) to 16 ML using a scanning tunneling microscope (STM). It was found that the growth of Co film on the InP(2×4) is drastically changed with respect to the film thickness. Below coverage of 1 ML Co, we observed anisotropical growth of Co atoms along the $[1\bar{1}0]$ direction of the substrate which corresponds to the row of the InP(2×4) reconstruction surface. Above coverage of 1 ML, we found random island formation and increase of island size. For further understanding of island growth of Co on the InP(2×4), we investigated the variation of root mean square (RMS) roughness dependent on Co film thickness. As coverage of Co film increase from 1 ML to 6 ML, the RMS roughness of Co film gradually increases which implies that island formation begins and island size increases at the vicinity of this coverage. However, in the thickness range from 7 ML to 13 ML, we found an abrupt increase in the RMS roughness of the Co film, which indicates the coalescence of Co islands. Further increasing the coverage up to 16 ML leads to decrease in the RMS roughness of the Co film again. We believe that it could be attributed to the occurrence of second nucleation on continuous Co film.

4.ACKNOWLEDGEMENT

This work is supported by the Korean Ministry of Science and Technology through the Creative Research Initiatives Project.

5. REFERENCES

[1] S. Datta, B. Dass, Appl. Phys. Lett. **56**, 665 (1990).

[2] H. J. Zhu, M. Ramsteiner, H. Kostial, M. Wassermeier, H.-P. Schönherr, K. H. Ploog, Phys. Rev. Lett. **87**, 016601(2001).

[3] A. T. Hanbicki, B. T. Jonker, G. Itsukos, G. Kioseoglou, A. Pertou, Appl. Phys. Lett. **80**, 1240 (2002).

[4] R. Fiederling, M. Keim, G. Reuscher, W. Ossau, G. Schmidt, A. Waag, L.W. Molenkamp, Nature (London) **402**, 787 (1999).

[5] Y. Ohno, D. K. Young, B. Beschoten, .Matsukura, H. Ohno, D. Awschalom, Nature (London) **402**, 790 (1999).

[6] M. Meyer, Compd. Semicond. **3**, 30 (1997).

[7] S. S. P. Parkin, Phys. Rev. Lett. **71**, 1641 (1993)