Modification of GaAs Surface by Self-Assembled Monolayers

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INTRODUCTION

The formation of the self-assembled monolayers (SAMs) on GaAs surface has attracted less attention despite its predominant use as a material for high frequency data transfer in the filed of communications. The assembly of organic layers on the GaAs surfaces proves to be more difficult than that on metal and Si surfaces due to the high tendency of oxide formation. The objective of the present work is to develop a universally applicable procedure to form SAMs with functionalized end-groups on GaAs. As proposed by Uosaki *et al.* previously,[1] the addition of NH_4OH into the alkanethiol solution is an effective way to overcome the chemical inertness of the GaAs surface and to provide a fresh and oxide-free GaAs surface.

In the present study, the formation and structure of the SAMs on GaAs surface were investigated using contact angle analysis, angle-resolve X-ray photoelectron spectro-scopy (XPS) and sum frequency generation (SFG) spectroscopy.

EXPERIMENTAL

The preparation of alkanethiol SAMs on GaAs surfaces followed the almost same procedures reported previously.[1] After etching in a concentrated HCl for 60 sec, surface derivatization of GaAs was performed in 5 mM alkanethiol solutions with the addition of 30 % aqueous ammonia solution at 50 °C for 8 h after purging with N_2. Physisorbed molecules was removed by rinsing with ethanol.

Contact angles were measured by CA-X (Kyowa Interface). XPS measurements were carried out by Rigaku XPS-7000 using a MgKα target. SFG measurements were carried out by a broad-band SFG system.[2]

RESULTS

Table 1 shows contact angle of SAMs/GaAs after treated by alkanethiol solution containing different amount of NH_4OH. When the NH_4OH was not included in the solution, contact angles of the modified GaAs surface did not change much with the length of the alkyl chain of the alkanethiol (~75 degree) and were higher than that of bare GaAs (~55 degree). The contact angle of GaAs modified by the long chain alkanethiol molecules (>12) increased much when concentration of NH_4OH was higher than 5%. For example, contact angle of ODT/GaAs increased from 77 to 113 degree when concentration of NH_4OH in 5mM ODT was changed from 0% to 20%. This result was in agreement with those obtained by the ATR-FTIR measurement.[1] On the other hand, the increase of the contact angle by addition of NH_4OH became smaller for the alkanethiol molecules with shorter alkyl chain.

Angle-resolved XPS measurement was carried out to determined the thickness of the alkanethiol SAMs on GaAs surface. SFG measurements were carried out to investigate the structure of the SAMs formed on GaAs surface. Detailed results and discussion will be given.

Reference

1. T. Baum, S. Ye, K. Uosaki, *Langmuir*, **1999**, 15, 8577-8579.
2. S. Ye, H. Noda, S. Morita and M. Osawa, submitted.

Table 1. Contact angles of SAMs/GaAs.

Concentration of NH_4OH	Contact Angle			
	C_4H_9SH	$C_8H_{17}SH$	$C_{12}H_{25}SH$	$C_{18}H_{37}SH$
0 %	75	70.3	76.3	77
0.2 %	78.2	78.6	78.3	77.3
0.6 %	79.3			84
1.8 %	79	71.3	78.7	83.3
3.0 %	80.3	77	81.7	82.7
5.0 %	82.6	84	102.6	106
15 %	81.3	87	100.6	107
20 %	82.3	88.3	103	113