Sample for e-Journal of Surface Science and Nanotechnology

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This document is a sample document for ‘e-Journal of Surface Science and Nanotechnology’. Although this {\LaTeX} document uses ‘REV\TeX\ 4’ class, which you can get and install ‘REV\TeX\ 4’ from ASP (American Society of Physics: ftp://aps.org/pub/revtex/), you can prepare the manuscript in Word as well. The templates for TeX and Word are available at our Web page http://www.sssj.org/eJSSNT. We observed a phase transition from a $\sqrt{3}\times\sqrt{3}$ to $3\times3$ phase on a Pb adsorbed Si(111) surface by scanning tunneling microscopy.

Keywords: You should choose keywords (five at most) from the list at http://www.sssj.org/eJSSNT; Scanning Tunneling Microscopy; Pb; Si(111);

I. INTRODUCTION

The phase transitions from the $\sqrt{3}\times\sqrt{3}$ to $3\times3$ phase on the Pb/Sn adsorbed Ge(111) surface at low temperature (LT) have attracted much attention since they were discovered,[1, 2] because a charge density wave (CDW) instability was thought to be a driving force of the phase transition. However, recently, based on angle resolved valence-band photoemission spectroscopy (PES), core-level PES, and surface X-ray diffraction (SXRD) experiments, the CDW for the driving force of the phase transition is seriously questioned.[37, 4] Particularly, based on the SXRD experiments, it was proposed that quasi-two dimensional cooperative Jahn-Teller mechanism contributed to the phase transition.[? ??] In this context, it is interesting how the $3\times3$ phase behaves at LT when the density of the substitutional defects increases.

We observed a phase transition from a $\sqrt{3}\times\sqrt{3}$ to $3\times3$ phase on a Pb adsorbed Si(111) surface by STM at 70 K (LT). They play an important role for giving electrons to the surroundings in place of the high concentration of Si defects at RT.

II. EXPERIMENTAL

Measurements were done with a commercially available STM equipped with a $\text{He}_2$-N$_2$ tank in an ultra high vacuum chamber (UHV) connected to a sample-preparation and load-lock chamber. Because Pb atoms are easy to desorb from the Si surface, the $\sqrt{3}\times\sqrt{3}$ phase, where the concentration of Si substitutional defects changes continuously, can be easily prepared. During the sample preparation process, pressure was kept below $2\times10^{-10}$ Torr.

III. RESULTS AND DISCUSSION

Fig. 1 displays a filled state STM image of a region with sloping the density of defects from 7 % to 20 % on the left- to right-hand side at 70 K. There are the regions with weak line modulations on the left-bottom and right-up corners, which are a $\sqrt{7}\times\sqrt{3}$ phase.[?] Bright hexagonal protrusions are arrayed with a $3\times3$ symmetry. Figs. 2(a) and (b) show a set of STM images in a region with the density of defects of 7 % which display filled- and empty- state images of the $3\times3$ phase at 70 K. In fig. 1, ratio between the concentrations of the S and M defects is about 4 to 1. Black linear/kinked defects consist of the Si defects and are characteristic structures for the Pb/Sn adsorbed Ge/Si(111) surface because these cause a mosaic phase through charge rearrangement induced by the Si defects at RT.

In fig. 1, corrugation changes continuously from the hexagonal modulations of the $3\times3$ phase to a mosaic corrugation on the left- to right-hand side. With the the density of defects increasing, the density of DB’s between two different domains increases whereas area of the $3\times3$ phase decreases. Figs. 2(c) and (d) show a set of STM images in a region with the density of defects of 20 % which display filled and empty state images respectively.

On the other hand, black spots as denoted by B in the filled state image appear as white protrusions in the empty state image, so they are not the Si defect. In the region with the higher the density of Si defects, the num-

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FIG. 1: A 430×417 Å2 filled state constant current STM image shows a region with sloping Si substitutional defects on the left- to right-hand side.

The equation that follows is set in a wide format, i.e., it spans across the full page. The wide format is reserved for long equations that cannot be easily broken into four lines or less:

\[ R^{(d)} = g_{e2} \left( \frac{[\Gamma^Z(3,21)]_{\sigma_1}}{Q_{12} - M_W^2} + \frac{[\Gamma^Z(13,2)]_{\sigma_1}}{Q_{13} - M_W^2} \right) + x W Q_e \left( \frac{[\Gamma^\gamma(3,21)]_{\sigma_1}}{Q_{12} - M_W^2} + \frac{[\Gamma^\gamma(13,2)]_{\sigma_1}}{Q_{13} - M_W^2} \right). \] (1)

TABLE I: This is a narrow table which fits into a narrow column when using two column formatting. Note that REVTEX 4 adjusts the intercolumn spacing so that the table fills the entire width of the column. Table captions are numbered automatically. This table illustrates left-aligned, centered, and right-aligned columns.

<table>
<thead>
<tr>
<th>Left</th>
<th>Centered</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>100</td>
<td>200</td>
<td>300</td>
</tr>
</tbody>
</table>

*Note a.*

*Note b.*

This is typed to show the output is in wide format. (Since there is no input line between \texttt{equation} and this paragraph, there is no paragraph indent for this paragraph.)

Fig. 3 shows a set of STM images, which display a filled- and empty-state images with the density of defects of 7%. Secondly, in the regions as pointed by a white arrow in fig. 3(a), any modulations do not happen in the filled state image. In the empty state, such regions also do not have any honeycomb patterns. However, it should be noted that the Si defects play an important role for formation of DB’s. Enclosing single-line and multiline equations in \texttt{\begin{subequations}} and \texttt{\end{subequations}} will produce a set of equations that are “numbered” with letters, as shown in eqs. (2a) and (2b) below:

\[ \begin{align*}
M & = ig_{e2}^2 (4E_1 E_2)^{1/2}(\epsilon_i^2)^{-1}(g_{e2}^2)^2 \chi_{-\sigma_2} (p_2) \\
& \times [\epsilon_i, \chi_{\sigma_1}, (p_1)]. 
\end{align*} \] (2b)

Putting a \texttt{\label{#1}} command right after the \texttt{\begin{subequations}}, allows one to reference all the equations in a subequations environment. For example, the equations in the preceding subequations environment were eqs. (2).

Although the formation of DB’s at 30 K were also mediated by the defects in their results, which were thought to move around on the surface below critical temperature of the phase transition through collective interaction between the substitutional defects and 3×3 phase, it is thought that discrimination between the B adatoms and substitutional defects should be needed. This is in favor of that the B adatoms donor electrons to the surroundings.

IV. CONCLUSION

In conclusion, we observed that the 3×3 phase on the Pb adsorbed Si(111) surface at 70 K. However, in such regions, there are the Pb atoms which appear as black spots in filled state STM images. They play an important
FIG. 2: An example of wide figure. Filled and empty state constant current STM images at 70 K.

TABLE II: This is a wide table that spans the page width in twocolumn mode. It is formatted using the \texttt{table*} environment. It also demonstrates the use of \texttt{\textbackslash multicolumn} in rows with entries that span more than one column.

\begin{center}
\begin{tabular}{cccc}
Ion & 1st alternative & 2nd alternative & 1st alternative & 2nd alternative \\
\hline
K & (2e) + (2f) & (4i) & (2e) + (2d) & (4j) \\
Mn & (2g)\textsuperscript{*} & (a) + (b) + (c) + (d) & (4e) & (2a) + (2b) \\
Cl & (a) + (b) + (c) + (d) & (2g)\textsuperscript{*} & (4e)\textsuperscript{a} \\
He & (8r)\textsuperscript{a} & (4j)\textsuperscript{a} & (4g)\textsuperscript{a} \\
Ag & (4k)\textsuperscript{a} & & & (4h)\textsuperscript{a} \\
\hline
\end{tabular}
\end{center}

\textsuperscript{a}The \( z \) parameter of these positions is \( z \sim \frac{1}{2} \).

FIG. 3: Filled and empty state constant current STM images of a region with the density of Si substitutional defects of 7\%. The scanning area was 393×405 Å\(^2\). Tip bias voltages were (a) 1.0 V and (b) −0.5 V. Tunneling current was 0.3 nA for all images. Temperature was 70 K.

role for giving electrons to the surroundings in place of the high concentration of Si adatoms on the mosaic phase at RT.

Acknowledgments

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