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Abstract

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Azimuthal dependence of impact scattering in electron energy loss spectroscopy

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Abstract

The azimuthal dependence of electron energy loss spectroscopy (EELS) dipole and impact scattering intensity has been measured. Spectra for a saturation coverage of H adsorbed on W(110) exhibit loss peaks due to impact scattering from adsorbate vibrational modes. The intensity of the 160 meV loss peak has been measured as a function of the azimuthal angle between the scattering plane and a mirror plane of the surface. The angular pattern has strong maxima oriented perpendicular to the <111 > rows of atoms on the surface, and has the C_{2v} symmetry of the W(110) surface. This azimuthal dependence is strikingly different from the nearly isotropic angular dependence of dipole scattering from Cl adsorbed on W(110). Selection rules for impact scattering account for the general features of the angular pattern based on asymmetric stretch modes associated with bridge site H atoms.

We have shown that the azimuthal dependence of the 36 meV Cl/W(110) dipole scattering loss peak is isotropic and that the 160 meV H/W(110) impact scattering loss peak exhibits a striking azimuthal pattern with C_{2v} symmetry. The symmetry and deep minima suggest that selection rules play a central role in determining the azimuthal pattern. Application of these rules to two orthogonal directions (as in ref. 6) may be misleading, as is clear from Fig. 2, because essential features of the pattern will not be observed. Our analysis of the full pattern has suggested two bridge sites may be occupied at saturation coverage, but has still not resolved certain questions about the H/W(110) system.

1. Impact scattering selection rules for potential adsorbate sites. The listed directions are the intersections of the planes with the (110) surface for the mirror planes and the scattering planes, and the displacement directions for the adsorbate vibrational modes. Modes are assumed to be strictly parallel to the surface. The long bridge site is between two W atoms along the <001 > direction, the short bridge site is between two W atoms along the $\langle 1\bar{1}1 \rangle$ direction, and the distorted bridge site is displaced from the long bridge site along the $\langle 1\bar{1}0 \rangle$ direction (ref. 6) The asterisks (*) denote that the scattering amplitude is zero for all directions in the scattering plane, otherwise it is zero only in the specular direction. The $\langle 1\bar{1}0 \rangle$ mode of the distorted bridge is not covered by the selection rules of ref. 2.

SITE	LONG BRIDGE	SHORT BRIDGE	DISTORTED
MIRROR PLANES	[001], $[1\bar{1}0]$	NONE	$[1\bar{1}0]$
2-FOLD ABOUT Z	YES	YES	NO
PARALLEL MODES	[001]	$[1\bar{1}0]$	$[1\bar{1}1]$
DIRECTIONS OF ZERO SCATTERING	[001] * $[1\bar{1}0]$	[001] * $[1\bar{1}0]$	$[1\bar{1}1]$ $[\bar{1}12]$

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