Analysis of periodicity in arrays of triple steps on vicinal surfaces: Period-dependent suppression of Fourier peaks

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We have investigated the peculiarities of atomic structures on vicinal surfaces Si(*h h m*), oriented at an angle close to 9.5° relative to the terraces (1 1 1). As a result, we have to consider the following surfaces: Si(8 8 11) (miscut angle of 8.93°, period of triple steps of L_3=18*b*=5.99 nm, where *b*=0.335 nm is the distance between atomic rows for the surface Si(1 1 1)1×1 in the [1 1 2] direction), Si(5 5 7) (9.44°, L_3=17*b*=5.65 nm) and Si(7 7 10) (10.0°, L_3=16*b*=5.32 nm). The expected difference in periods for these surfaces is rather small (about 6%) and can be easily masked by distortions in the scanning plane caused by thermal drift and/or creep of piezo scanner. We propose a novel method for determining the periodicity of a system of triple steps.

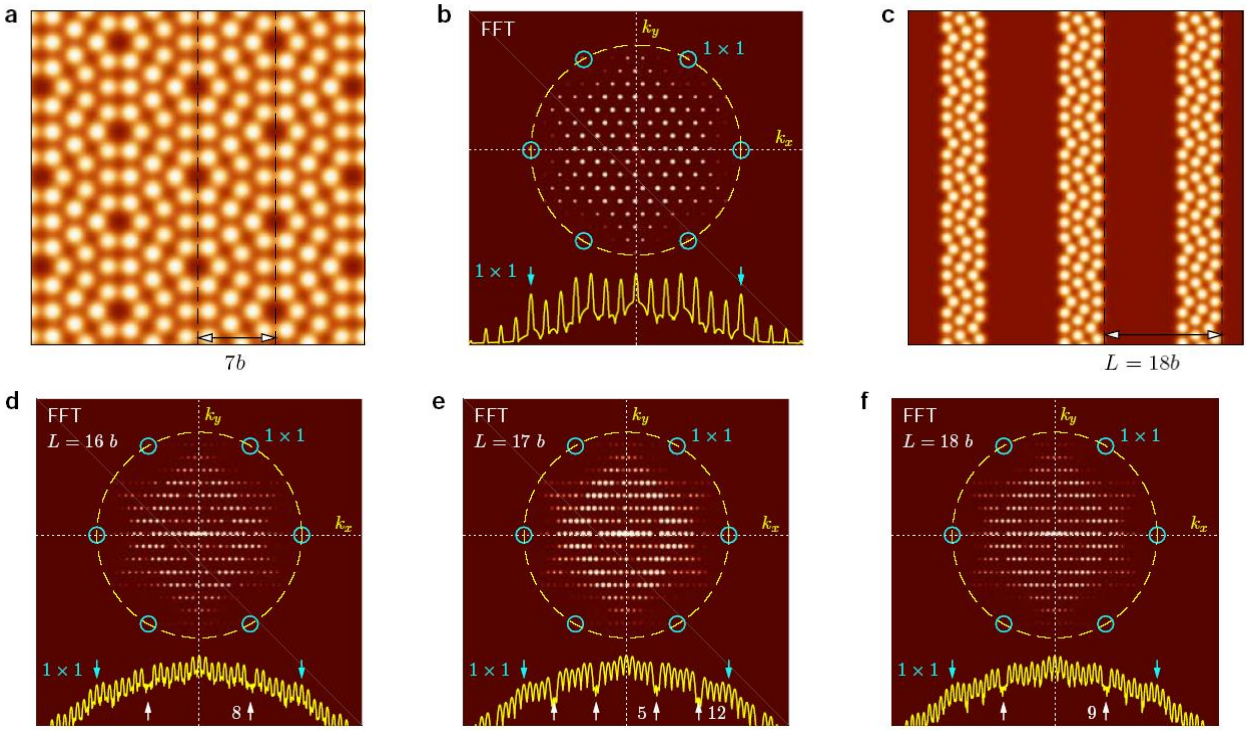

Fig. 1. **a, b** – Model surface Si(1 1 1)7×7 and corresponding Fourier transform $z(k_x, k_y)$, yellow curve in the bottom part of panel b depicts the dependence ln $|z(k_x, k_y=0)|$. **c** – A fragment of the model structure representing periodically repeating strips of the Si(1 1 1)7×7 reconstructions with period *L*. **d-f** – Fourier transform $z(k_x, k_y)$ for the periodical patterns with periods 16b (d), 17b (e) and 18b (f). The radius of the circle marking the expected positions of the first-order Fourier peaks for the Si(1 1 1) 7×7 lattice, is equal to 18.89 nm^{-1}.

We note that there are areas with 7×7 reconstruction on (1 1 1) terraces for vicinal surfaces Si(8 8 11), Si(5 5 7), and Si(7 7 10) (Fig. 1c). We have shown that the Fourier transforms of topography images for such structures could contain split Fourier peaks (Fig. 1, panels d-f). Depending on the period of the superstructure, one or two peaks on the dependence of $|z(k_x,k_y)|$, composed for $k_y=0$, become suppressed. This enables us to uniquely determine the structure period and establish Miller indices for the considered vicinal surfaces. For vicinal surface Si(*h h m*), studied experimentally, proper alignment can be done using the difference-of-Gaussian approach [1]. Fourier analysis of differential topographic images obtained by scanning tunneling microscopy unequivocally indicates suppression of the ninth Fourier peak (at k_x= 9,45 nm^{-1} and $k_y=0$, Fig. 1f). It apparently corresponds to the formation of Si(8 8 11) surface [2].

Bibliography

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