Periodic Quasiparticle Energy Band Tunability in Striped MoS_2 Superstructures

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Abstract

Although the recently discovered monolayer transition metal dichalcogenides (TMDCs) exhibit novel electronic and optical properties, fundamental physical issues such as the quasiparticle band-gap tunability and substrate effects remain undefined. Herein, we present the first report of a quasi-one-dimensional periodically striped superstructure for monolayer MoS_2 on Au(100). The formation of the unique striped superstructure is found to be mainly modulated by the symmetry difference between MoS_2 and Au(100) and their lattice mismatch. More intriguingly, we find that the monolayer MoS_2 is heavily n-doped on the Au(100) facet with a bandgap of 1.3 eV; the Fermi level is upshifted by ~0.10 eV on the ridges (~0.2 eV below the conduction band) in contrast to the valley regions (~0.3 eV below the conduction band) for the striped patterns. This tunable doping effect is considered to be mediated by the weak/strong coupling effects between MoS_2 and Au(100) with respect to the ridge/valley regions. Additionally, an obvious bandgap reduction is observed in the vicinity of the domain for monolayer MoS_2 on Au(100). This work should therefore inspire intensive explorations of adlayer-substrate interactions and their effects on band-structure engineering of monolayer MoS_2.

References

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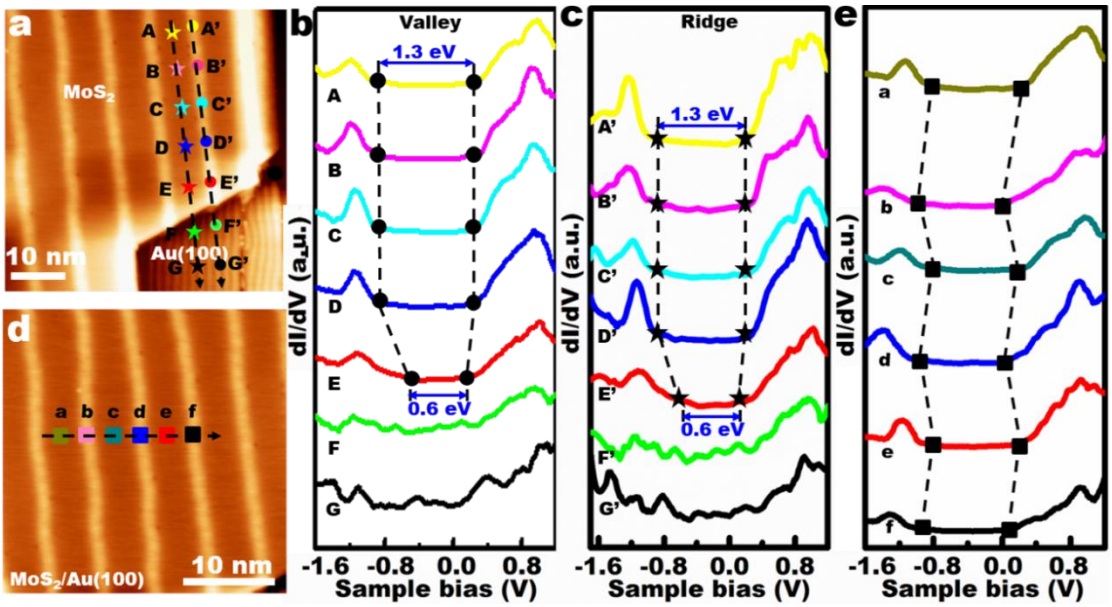
Figures


a
A
A'
B
B'
MoS2
C
C'
D
D'
E
E'
F
F'
G
G'
10 nm
Au(100)
d
a b c d e f
MoS2/Au(100)
10 nm
b
Valley
1.3 eV
0.6 eV
dI/dV (a.u.)
-1.6 -0.8 0.0 0.8
Sample bias (V)
c
Ridge
1.3 eV
0.6 eV
dI/dV (a.u.)
-1.6 -0.8 0.0 0.8
Sample bias (V)
e
dI/dV (a.u.)
-1.6 -0.8 0.0 0.8
Sample bias (V)