Conventional wisdom tells us that carbon forms $\pi$-bonds while silicon does not. Silicon surfaces break the rule, since the broken bonds are desperately seeking a bonding partner. They rearrange themselves to form in-plane $\pi$-bonds. Such a rearrangement of surface atoms is called surface reconstruction.
By varying the sample voltage in a scanning tunneling microscope one can detect either the occupied, bonding $\pi$ orbitals, or the unoccupied, antibonding $\pi^*$ orbitals. As for the $\text{H}_2$ molecule, the bonding orbitals accumulate charge between two atoms to form a covalent bond, while the antibonding orbitals have a zero (= node).
> 100 atoms rearrange themselves to minimize broken bonds.
Two mechanisms for the stability of Si(111)7x7

Adatoms trade three broken bonds for one. They form the bumps in the STM image.

Broken bonds disappear when holes are created at a stacking fault.
Surface structures and \( n \times m \) superlattices

\[
\begin{align*}
\text{(a) } & \text{fcc}\{111\} \times 1 \\
\text{(b) } & \text{fcc}\{111\} \times 2 \\
\text{(c) } & \text{fcc}\{111\} \sqrt{3} \times \sqrt{3} \ - \ R30^\circ \\
\text{(d) } & \text{fcc}\{110\} \times 1 \\
\text{(e) } & \text{fcc}\{110\} \times (2 \times 2) = \text{centered} \ 2 \times 2
\end{align*}
\]

Fig. 17-5 Several surfaces of face-centered cubic crystal showing different surface structures. The side of the conventional cubic unit cell is \( a \). In (a) through (c) a \{111\} face is shown and in (d) and (e) a \{110\} face is shown.
Ionic crystal surfaces need to be neutral
Otherwise an infinite charge sheet builds up at the surface with infinite Coulomb energy.

NaCl(100) surface
(with the approximate size of the ions)