

# **Atomic and Electronic Processes and Interface Polarization Changes during the Cyclic Growth of NaCl on Si, Ge(100)**

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## **Abstract**

An atomic layer of stoichiometric NaCl was formed on a covalent Si(100) surface after two successive half-reactions at room temperature. The first half-reaction due to Cl<sub>2</sub> exposure generates a square array of Cl adatoms with a distance close to that in a NaCl(100) surface plane. By utilizing scanning tunneling microscopy (STM) and core-level photoemission spectroscopy, it was found that progressive deposition of Na in the second-half reaction results in clusters, patches, and eventually turns the Cl-adlayer into a single-terrace, wavy NaCl layer at one monolayer Na coverage. The grown NaCl monolayer rolls over atomic steps like a carpet and covers the entire surface. The atomic and electronic structure of the topmost Si layer underneath the NaCl layer resembles that of the initial silicon surface layer with buckled dimers. Results of the comprehensive investigation together suggest that an ionic NaCl monolayer is very weakly bonded to the covalent substrate and appears nearly free standing.

The same two-cycle method leads to the layer-by-layer growth of NaCl films on Ge(100). Synchrotron radiation photoemission is employed to examine in situ the atomic and electronic structure. The Ge 3d photoemission spectrum obtained after full cycles of growth of stoichiometric NaCl resembled that of clean Ge(100)-(2×1), but came to resemble that of Cl-terminated Ge(100)-(2×1) after the subsequent half reaction of Cl adsorption. These variations were accompanied by concurrent periodic energy shifts by ~1.7 eV of the Na and Cl core levels. Our results demonstrate oscillations between van der Waals bonding and ionic bonding and alternation in polarization at the NaCl-Ge interface.