Spontaneous growth of silver on Si(001) tuned by substrate temperature

Xiaohang Huang,[1] and Kai Huang[1]

[1] *Chemistry Program, Guangdong Technion-Israel Institute of Technology, No. 241, Daxue Road, Shantou, Guangdong Province, China, 515063.*

The development of semiconductor technology features miniaturization of device that approaches the physical limit, i. e., nanostructure of a few atoms and/or molecules. It has been aimed that one could use nanostructures to fabricate functional devices at will. For the system of silver on Si(001), there is a rich collection of nanostructures as revealed in our recent works [1, 2], serving as the candidates to test this aim.

In this work, we examined the spontaneous growth of silver on Si(001) held at 109 to 298 K by scanning tunneling microscopy. As shown in Figure 1, the dimension of the formed silver depends on the substrate temperature during the deposition. That is, silver is formed predominantly as zero-dimensional (0D) objects at less than 120 K, one-dimensional (1D) objects at 120-200 K, and two-dimensional (2D) objects at 200-270 K. These observations are linked to the anisotropic migration of the key intermediate of silver tetramer, as supported by density functional simulations; the barriers are calculated as 0.24 eV along Si-rows, and 0.68 eV across Si-rows [2]. A schematic of the growth dynamics is sketched in Figure 2.

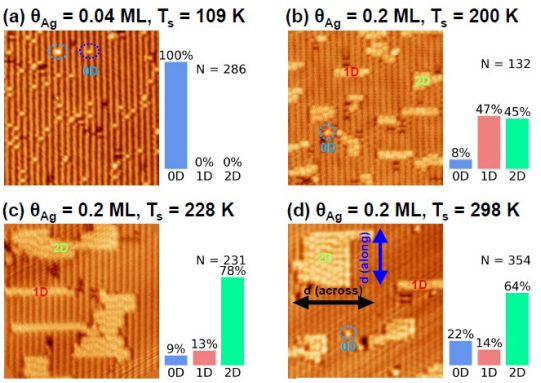

Figure 1. (a)-(d) STM images of Ag deposited on Si(001) held at 109, 200, 228 and 298 K.

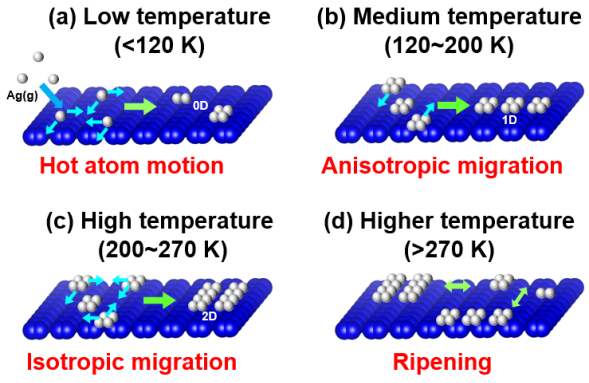

Figure 2. Interpretation of spontaneous formation of silver structures on Si(001) at (a) low (b) medium (c) high and (d) higher temperatures.

[1] K. Huang, X. Huang, J. Nogami, Phys. Chem. Chem. Phys. **7**, 23 (2021).
[2] X. Huang, A. Hoffman, K. Huang, J. Phys. Chem. C. **18**, 126 (2022)

+ Author for correspondence: kai.huang@gtiit.edu.cn