Striking Influence of Nickel Surface Changes on the Growth of Cobalt Nanostructures

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The influence of the carbide (Ni_2C) layer, formed on Ni(100) surface, on the growth of Cobalt (Co) nanostructures, is revealed via complementary scanning-tunneling microscopy (STM) measurements and the first-principles calculations [1]. On clean Ni(100) below 200°C, Co forms randomly distributed two-dimensional (2D) islands, while on Ni_2C three-dimensional (3D) two-atomic-layers thick islands are observed in STM images. We present a simple yet powerful model that elucidates the substantial differences in the Co growth mode on the two surfaces. On stepped surfaces, the observed formation of jagged step decoration of Ni_2C, not visible on Ni(100), is explained by the sharp differences in the mobility of Co atoms in the two cases. With the increase of temperature, the dissolution process starts and finally STM scanning of Ni(100) surface at 250°C revealed almost no remaining Co, whereas some Co islands are still being visible on Ni_2C surface up to 300°C. Computational results corroborated the ability of Co to persist on the Ni_2C surface up to higher temperatures and suggested a vacancy-assisted model for its dissolution in Ni(100). The methodology presented here systematically combines the STM measurements with the first-principles calculations and computational modeling, thus opening the new route towards the selective modification of metallic surfaces through the deposition of metal atoms of another species and the control of temperature.

References

[1] V. Chesnyak, S. Stavrić, M. Panighel, G. Comelli, M. Peressi, C. Africh, to be submitted

Figures

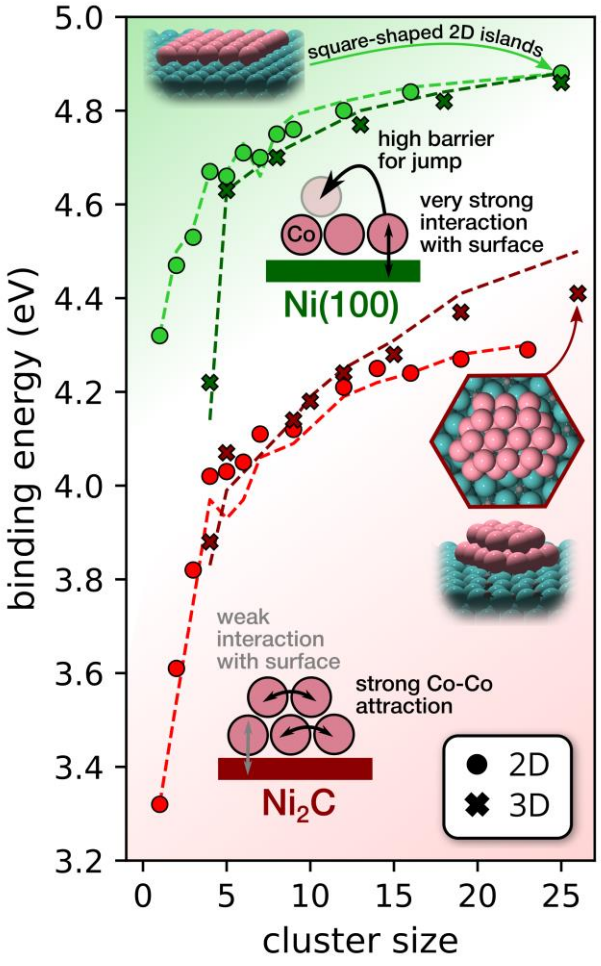

Figure 1: Binding energy of Co clusters up to ~25 atoms in size calculated directly by DFT (circles and crosses) fitted to the estimate from the model (dashed lines). In the inset the schematic representation of the important players that determine the shape of Co nanostructures on each surface together with the most stable structures with ~25 atoms are depicted.