Nanostructures of s- and d-metals on van der Waals surfaces of InSe and GaSe semiconductor single crystals

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The formation mechanisms of Cu, Ag, and Au nanoreliefs on the surface of InSe and GaSe single crystals during multistage thermal deposition have been investigated.

Vacuum thermal deposition of Cu and Au (without sample cooling and the presence of inert gases) on the surface of an InSe (0001) single crystal at the same deposition conditions demonstrates different deposition mechanisms from the atomic metal gas phase.

On van der Waals surfaces, copper forms clusters with a monomodal distribution (Fig. 1), while gold forms monolayers of a flaky structure. A small influence of the interface surface on the geometry and symmetry of the created nanostructures of copper and gold is established. The processes of formation of copper and gold nanostructures under these conditions are badly described by the known growth mechanisms.

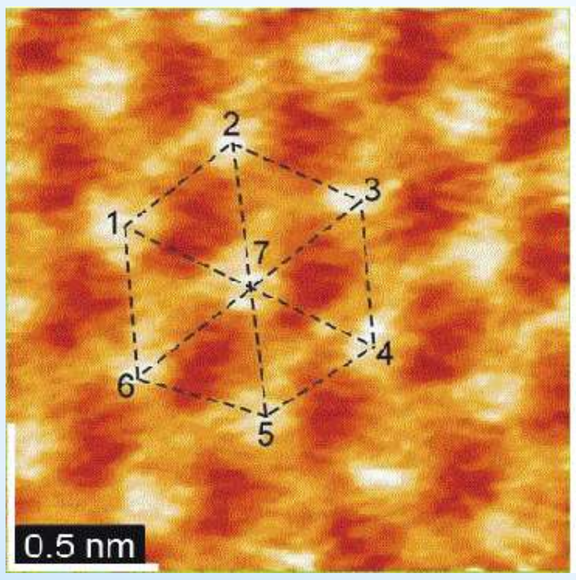


Fig. 1. STM images of the InSe (0001) single crystals surface.

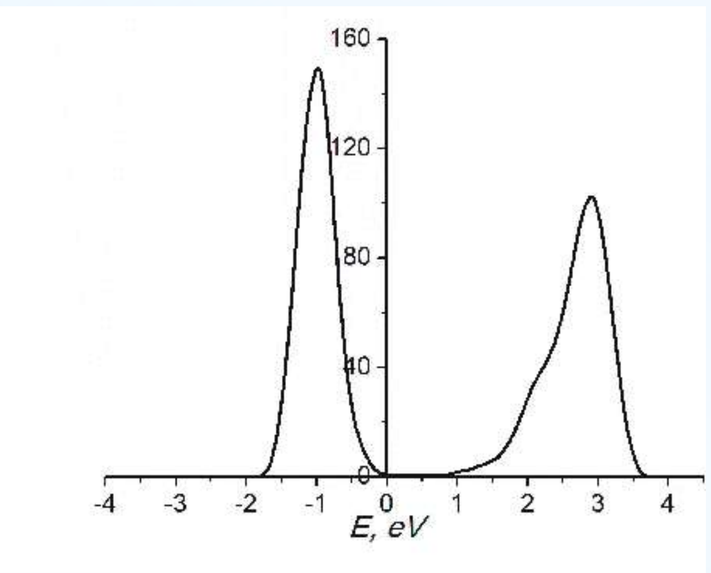
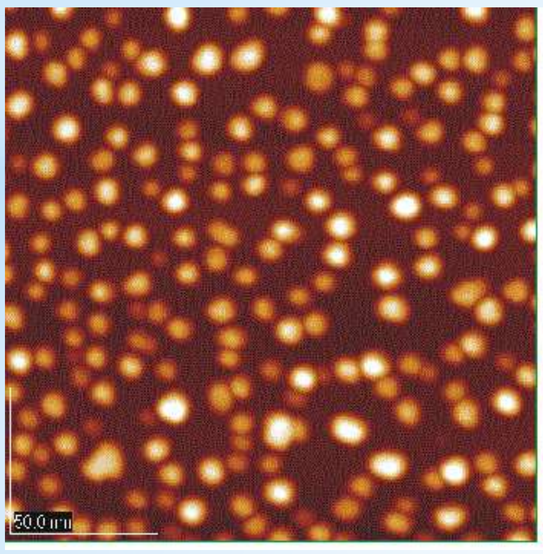


Fig. 2. Tunneling spectroscopy spectra of InSe (0001).

It is shown that the density of electronic states curves obtained experimentally by the method of tunneling spectroscopy and calculated within the density functional theory method are in good agreement.



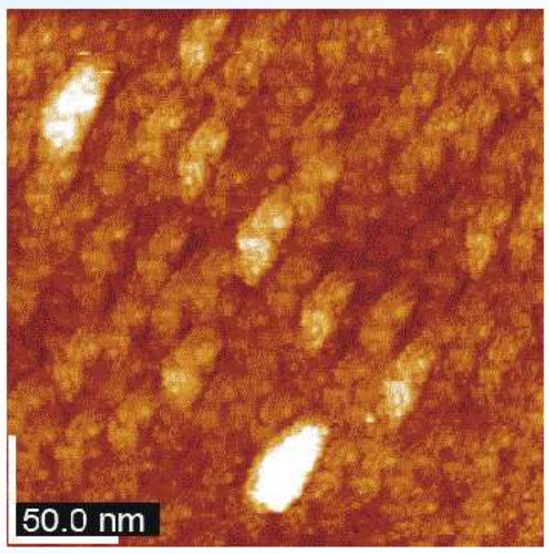
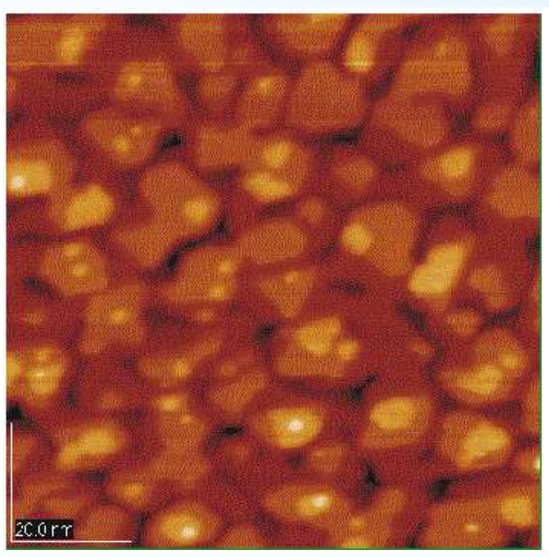


Fig. 3. Tunnel microscopic images of copper surface on InSe (0001) (JSPM-4610 tunnel microscope).

On the van der Waals surface, copper forms clusters with a monomodal distribution (Fig. 3. 1).



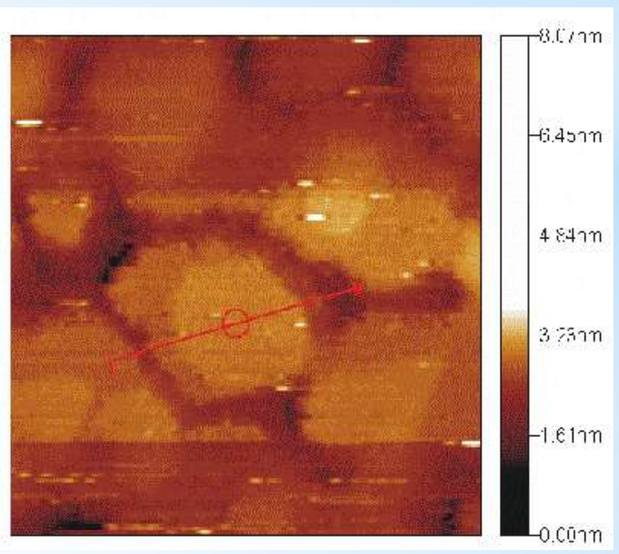


Fig. 4. Geometrically regular Au structures on the single-crystal InSe (0001) surface (JSPM-4610 tunneling microscope).

Unlike a silicon single-crystal surface, on the InSe surface, the growth of gold structures of the same height is observed, but not their layering (Fig. 4).

CONCLUSIONS

A technology for obtaining mono- and multilayer nanostructures of Cu, Ag, and Au metals on the InSe and GaSe single crystals surfaces has been developed.

It was found that, due to the non-wettability of the InSe single-crystal surface, noble metal nanoparticles are obtained in the form of a spherical shape.