Two-dimensional semiconducting Gold

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Within the two-dimensional (2D) material research of the past decade, we have seen a large variety of materials synthesized. The great majority of them derive from their layered homologue in three dimensions. This is the case for graphene [1], hexagonal boron nitride (h-BN) and (almost all) the transition metal dichalchogenides (TMDs), which are the main ingredients in the recent quest towards the realization of van der Waals heterostructures (vdWHs) with tailored electronic properties. Other 2D materials such as germanene (Ge), silicene (Si), bismuthene (Bi) and phosphorene (P) have been synthesized on various substrates, but those materials come from crystal structures, which are not layered in the bulk and are therefore intrinsically unstable. A category of materials which have proven to be arduous to synthesize on a large scale is represented by transition metals, where so far no large-area high quality crystal has been reported [2]. In this work we show that gold atoms, intercalated at the heterointerface between the Si-terminated SiC(0001) surface and its C-rich $(6\sqrt{3}\times 6\sqrt{3})R30$ reconstruction [3], are arranged in a highly crystalline fashion and develop their own band dispersion, which is intrinsically two-dimensional. By means of angle-resolved photoemission spectroscopy (ARPES), we measured the electronic dispersion of 2D-Au, observing a maximum of the valence band slightly below the Fermi level [4]. Along the Au $\Gamma\mathrm{K}$ direction, the 2D-Au bands also exhibit a large spin-orbit splitting, which could turn out to be useful for spintronic applications. The graphene/gold interface was investigated in detail with several surface analysis techniques to assess its structure and chemistry. Scanning tunneling microscopy (STM) scans reveal an atomically clean and sharp interface, with gold developing a (13×13) moiré. We therefore present the first experimental observation and thorough characterization of a large-area 2D semiconducting gold layer. Being graphene-encapsulated, this also defines a novel type of van der Waals heterostructure.

References

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Figures

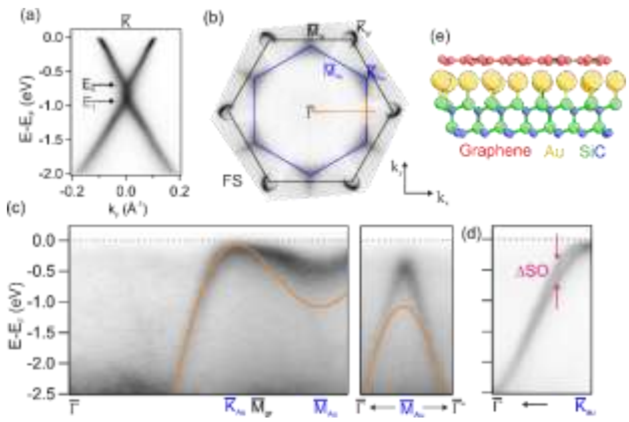

Figure 1. Electronic properties of 2D-gold graphene encapsulated.

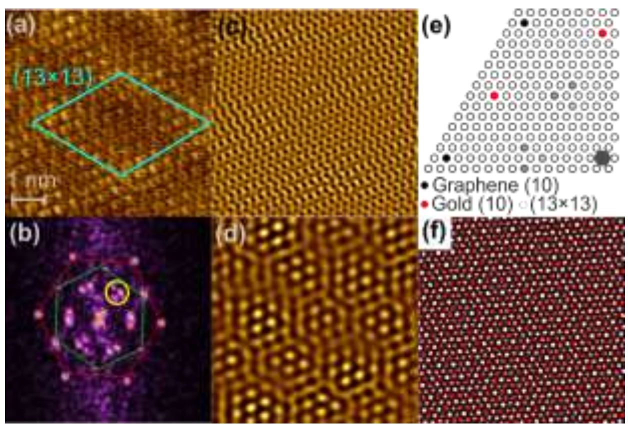

Figure 2. Local STM measurements of the moiré potential stemming from the Gr/Au/SiC(0001) interface.