Evidence for epitaxial germanene formation on AlN(0001)/Ag(111) template

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Abstract

Free standing silicene and germanene, has been predicted to be stable in the low buckled (LB) configuration, preserving the Dirac cone at K-points of Brillouin zone (BZ) although observation of π-bands remain elusive [1]. The first experimental works on germanene growth appeared only recently, reporting on the germanene formation on Pt(111) [2] and Au(111) [3] substrates. Nevertheless, the growth of metal-supported germanene/silicene has drawbacks because of the strong interactions between the substrate and the 2D layers. The deposition of Ge on Ag(111) at 1/3 coverage show strong cone-like features which are attributed to strong Ge-Ag interactions forming Ag_2Ge surface alloy [4]. On the other hand, it has been theoretical predicted that germanene can stably attach through weak van der Waals interactions on another 2D graphite-like material, such as hexagonal (h-) boron nitride (BN) [5].

In this work we present the growth of Ge layer on 2D hexagonal (h)-AlN nanosheets on Ag(111) [6]. Ge layers were deposited by molecular beam epitaxy (MBE) on Ag(111) with and without h-AlN buffer layer and were structurally characterized by RHEED, EXAFS measurements and first-principle calculations-DFT. The RHEED spectra of Ge layer on h-AlN (Fig. 1) present a (4x4) Ge reconstruction with respect to (1x1) h-AlN, or a (3x3) reconstruction with respect to (1x1) germanene. EXAFS structural analysis on the Ge layers deposited on the pure Ag surface shows a Ge-Ge distance that is typical of Ge bulk islands, while the Ge deposited on the buffer h-AlN layer presents a significant structural difference indicating buckled germanene with Ge-Ge bond length near the free standing value.

References

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Figures

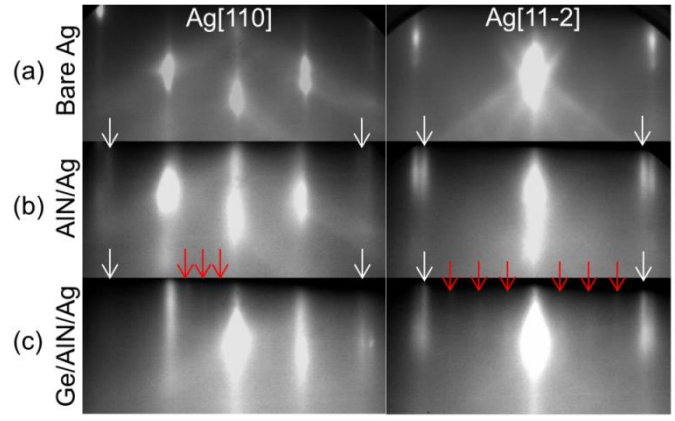

Figure 1: RHEED patterns of: **(a)** bare Ag(111), **(b)** epitaxial AlN buffer layer on Ag(111) and **(c)** 1ML Ge deposited on epitaxial AlN/Ag(111) template, along [110] (left) and [11-2] (right) azimuths of silver, respectively. The white and red arrows indicate the AlN and Ge diffraction streaks, respectively. In (b) the (1x1) hexagonal AlN reconstruction is shown while in (c) after the Ge deposition, a (4x4) Ge reconstruction with respect to (1x1) hexagonal-AlN is observed.

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