Small polarons in single layer $MnBr_2$: substrate dependence and interaction with a super-moiré

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Single-layer transition metal dihalides grown on conducting substrates were shown to host small polarons [1,2]. Here, we investigate polarons in insulating single-layer $MnBr_2$ grown by molecular beam epitaxy on three different substrates, namely graphene on Ir(110), graphene on Ir(111), and Au(111). The number densities and species of polarons observed vary strongly as a function of the substrate. For $MnBr_2$ grown on Ir(110) the largest number of polaron species is observed, namely four, of which three show clear similarities with the species observed for $CoCl_2$ on graphite [1]. Polarons in single-layer $MnBr_2$ are observed up to 300 K, indicating a remarkably high barrier to thermal hopping. They can be created, converted, and moved by the STM tip when a tunneling current flows at a proper bias voltage. The presence of an equilibrium distribution of polarons within tunneling distance to a conducting substrate implies a large magnitude of the polaron formation energy. Our findings indicate that modeling of polarons in such single-layer insulators in contact with a conducting substrate requires to take the substrate explicitly into account. For graphene on Ir(110) as a substrate, mobile polarons in $MnBr_2$ are guided through the periodic potential imposed from the super-moiré resulting through the interaction of $MnBr_2$ with graphene and Ir(110) [3]. While this discovery is of fundamental interest, it implies that, in principle, it is possible to construct devices in which a laterally patterned potential may guide the motion of polarons.

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