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Spatial modulations of the density of states due to atomic defects in bulk ZrSe2

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$ZrSe_2$ is a transition metal dichalcogenide (TMD), isoelectronic with $TiSe_2$. Yet, the two materials are strikingly different. $TiSe_2$ is a semi-metal hosting a 2x2 charge density wave (CDW) phase, while $ZrSe_2$ in its pristine bulk form is an insulator and does not support a CDW phase. However, a recent study of mono- and few-layer $ZrSe_2$ on graphene reports the observation of a 2x2 CDW driven by charge transfer from the substrate. [1] Here we use low-temperature scanning tunnelling microscopy (STM) and spectroscopy (STS) to study in-situ (UHV) cleaved bulk $ZrSe_2$ crystals. We present a spectroscopic investigation of various native defects and the spatial extent of their influence on the electronic structure of $ZrSe_2$. Our study finds spatial modulations in the LDOS consistent with the previously reported results. These observations suggest that a similar CDW phase in bulk $ZrSe_2$ may be driven by native atomic defects.

[1] Ren et al., Nano Letters 22 476-484 (2022).