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Strain-Induced Relocation of Topological Surface States in Bi_2Se_3 Single Crystal

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To investigate the impact of strain on the surface and bulk electronic states of solids, we have developed a new sample holder for *in-situ* strain application for ARPES experiments at low temperatures. In this study, we report the design of the sample holder and ARPES results of a strain-induced modification of the surface and bulk states of Bi_2Se_3 single crystal. Our findings reveal significant alterations in the electronic band structure [6] (in terms of energy and momentum) of the Bi_2Se_3 layered topological insulator [1-4] when subjected to tensile strain. Specifically, tensile strain leads to a closer proximity of the Dirac point (DP) to the Fermi level (lower binding energy), while compressive strain results in the DP moving further away from the Fermi level (higher binding energy). This study demonstrates the tunability of both surface and bulk electronic states in Bi_2Se_3 through the *in-situ* application of strain and underscores the potential of strain engineering for "Straintronics" [5] devices. The sample holder developed for this purpose holds promise for advancing research on the electronic band structures of layered materials, including topological insulators and quantum materials [6-8], under strain conditions.

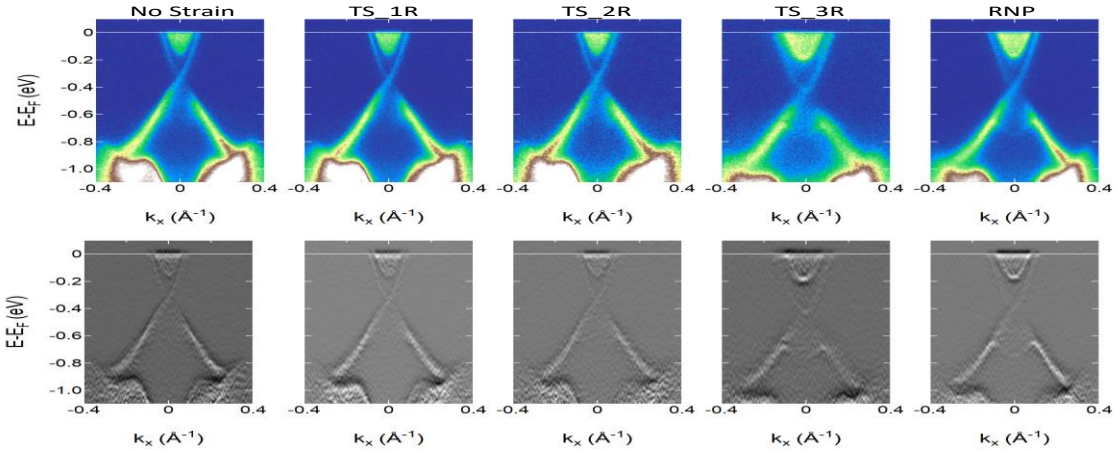

FIGURE 1. ARPES maps along $\bar{\Gamma} - \bar{K}$ for Bi_2Se_3 single crystal with increasing tensile strain (TS) from TS_1R, to TS_2R, to TS_3R measured at 10 K with 25 eV photon energy. The DP moves to the lower energy. The DP position was not recovered to the original position though we remove the tensile strain (RNP).

TABLE 1. Changes in fermi velocity, bottom of conduction band and shift in dirac point with respact to applied starin.

Change in parameters	***No Strain***	***TS_1R***	***TS_2R***	***TS_3R***	***RNP***
$k_F(\text{Å}^{-1})$	0.0848	0.0846	0.0876	0.1037	0.1080
Bottom of conduction band (eV)	-0.1555	-0.1605	-0.1655	-0.1806	-0.1856
Dirac Point (eV)	-0.3398	-0.3520	-0.3584	-0.3729	-0.3862

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