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Direct observation of distributed topological surface current flow in $Bi_{1.5}Sb_{0.5}Te_{1.7}Se_{1.3}$ single crystals JANGHEE LEE, JAE-HYEONG LEE, JOONBUM PARK, JUN SUNG KIM, HU-JONG LEE, Department of Physics, Pohang University of Science and Technology — Topological insulators (TIs) reveal new quantum states of matter, with the topological surface conducting state (TSS) on the insulating bulk. Accurate transport measurements on a TI surface offer crucial information on the topological nature of the TSS. But, with dominant surface conduction, current flow on the top surface of a TI is not confined between the current-biasing electrodes but are widely distributed over the entire surfaces of a TI, including the sides. This distributed current flow makes the estimation of the surface conductance erroneous, leading to difficulties with characterizing the topological nature of the TSS. In this study, we overcome the problem, by concurrent measurements of the local and nonlocal conductance of $Bi_{1.5}Sb_{0.5}Te_{1.7}Se_{1.3}$ TI crystalline flakes, in combination with the comprehensive numerical simulation, which yields highly relevant backgate-voltage, temperature, and magnetic-field dependences of the conductance on the top and bottom surfaces. Our study provides a reliable means of accurately characterizing the TSS with inherent nonlocal surface-dominant conducting channels in a TI.

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