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Multinary sulphides for thermoelectrics: Mechanochemical synthesis via industrial milling

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Discovering sustainable, low-cost and clean energy sources represents one of the most important challenges for materials science. Thermoelectric materials offer a viable way to generate electricity from waste heat without hazardous side products. However, their application remains limited because the best-known materials are based on toxic, scarce and costly compounds with low chemical stability under operating conditions. Several new compounds with high thermoelectric performance have recently emerged. Among them, metal chalcogenides have attracted considerable attention as potential Te-free alternatives. In this work we describe the properties and thermoelectric performance of several copper-based multinary sulphides, namely chalcopyrite $CuFeS_2$, tetrahedrite $Cu_{12}Sb_4S_{13}$, mawsonite $Cu_6Fe_2SnS_8$ and colusite $Cu_{26}V_2Sn_6S_{32}$. All of them were prepared via mechanochemical synthesis in an industrial mill. Using this procedure all benefits of mechanochemistry can be utilized [1-4]. As for thermoelectrical parameters, the Seebeck coefficient, electrical conductivity and thermal conductivity were measured and confronted with energy supplied during milling. The obtained values were used to calculate the figure-of-merit (zT). zT values are comparable or even higher than the values obtained using laboratory mills. The presented results illustrate the possibility of a large-scale deployment of mechanochemistry to prepare energy-related materials.

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