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Self-propagating high temperature synthesis for compound thermoelectrics and new criterion for applicability of combustion processing[1]

XINFENG TANG, XIANLI SU, Wuhan University of Technology, CTIRAD UHER, University of Michigan, TANG'S GROUP TEAM, UHER'S GROUP TEAM — Here we report compound thermoelectric materials (Bi_2Te_3, Bi_2Se_3, Cu_2Se, Cu_2SnSe_3, half-Heusler alloys, lead chalcogenides, skutterudites, and magnesium silicides) with thermoelectric properties comparable with materials prepared by the traditional routes of synthesis can be synthesized at a minimal cost and on the time scale of seconds using the self-propagating high temperature synthesis method. Moreover, we found that the criterion often quoted in the literature as the necessary precondition for combustion synthesis, $T_{\mathrm{ad}} \geq 1800$ K, is not universal and certainly not applicable to thermoelectric compound semiconductors. Instead, we offer new empirically-based criterion, $T_{\mathrm{ad}}/T_{\mathrm{m,L}} > 1$, i.e., the adiabatic temperature must be high enough to melt the lower melting point component, which covers all materials synthesized by self-propagating high temperature synthesis, including the high temperature refractory compounds for which the $T_{\mathrm{ad}} \geq 1800$ K criterion was originally developed. Our work opens a new avenue for ultra-fast, low cost, mass production fabrication of efficient thermoelectric materials and the new criterion greatly broadens the scope of materials that can be successfully synthesized by self-propagating high temperature synthesis.

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Xinfeng Tang
Wuhan University of Technology

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