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"Disordered" organic thermoelectrics: Venue to improve performance

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"Disordered" organic thermoelectrics have been shown to possess figure-of-merits (ZT) somewhat comparable to the best nano-structured inorganics. The reason appears to be related to the treatments that will increase carrier density (to values approaching that of a metal) while maintaining ultra-low thermal conductivity. Recent values of ZT approaching one have been reported in conducting organics even though details were not provided as to how physical changes could improve performance. As is well known, the parameters pertaining to the figure-of-merit of ZT ($=S^2T/\rho\kappa$) include the "Seebeck" coefficient S; the electrical resistivity ρ; and the thermal conductivity κ, all of which can be interrelated. In this work, we outlined the established theories linking charge and heat transport to parameters as appearing in the literature and showed how individually they affected the thermoelectric figure-of-merit. As anticipated, there will be barriers making it difficult to control/optimize one set of parameters without affecting the rest. This is more critical when the conductivity of the organics borders between that of a metal and a semiconductor. An attempt will be made to identify the effects under such a transition. To improve performance, we will pay particular attention to the thermal relaxation process and how phonon relaxation time can be minimized. As expected, optimization will require a balancing between thermal and electronic transport with potentially the former playing the leading role.

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