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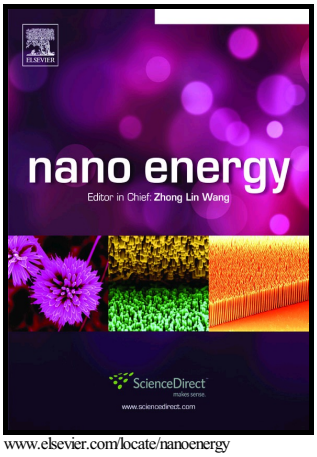

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Visualizing nanoscale heat pathways

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Abstract:

We developed a method to visualize heat conduction pathways with nanoscale spatial resolution using scanning transmission electron microscopy (STEM) and a nanothermocouple assembled in a transmission electron microscope (TEM). Through combining a scanning heat input under STEM with the nanothermocouple piezo-driven movements and its precise positioning, we entirely controlled a heat flow through a tiny TEM specimen. We were also able to construct two-dimensional nanoscale heat maps which visualize the heat pathways in a nanocomposite material, *i.e.* alumina nanofillers embedded into an epoxy matrix. The method possesses unprecedentedly high temperature and spatial resolutions which allows for its smart implementation into nanoscale studies of thermal flow propagation within novel thermoelectric conversion materials, thermal diodes, heat-sink materials, *etc.* Various phenomena associated with heat can be also simultaneously analyzed *via* combined and comprehensive thermal tests inside TEM while merging them with structural, mechanical, electrical, magnetic, and optoelectronic characterizations of a material down to the atomic scale.