Enabling Novel Radiative Applications via Directional Control of Thermal Emission

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Thermal radiation, characterized by its medium-free nature and high efficiency, offers distinct advantages over conduction and convection[1]. Historically, its applications have been constrained by isotropic emission profiles[2]. Recent advancements in nanophotonics have enabled precise directional control of thermal emission[3], unlocking new possibilities in thermal management.

In radiative cooling applications, vertical building surfaces often absorb significant thermal radiation from the ground, which is heated by solar exposure. We have developed an asymmetric emitter designed to reflect ground-emitted radiation, thereby enhancing the net cooling effect on vertical surface.[4]

For radiative heating, our proposed designs of the directional emitter maximizing energy transfer efficiency. Furthermore, we present a theoretical framework categorizing practical scenarios and propose generalized methods to achieve uniform thermal radiation.

Our work underscores the potential of directional thermal radiation control in enhancing the performance of radiative cooling and heating systems, as well as in achieving uniform heat transfer in advanced thermal applications.

References

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