An impedance based formulation for passive radiative cooling system design

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In recent years, passive radiative cooling has become a widely studied field as a solution to the problem of undesired heat generation problem in open environments. Several forms of daytime radiative cooling devices have been proposed in the literature depending on the applications, e.g., thin-films, metamaterials and those composed of nanoparticles [1–4]. Although various design approaches are reported for radiative coolers, they do not benefit from the existing design approaches that are heavily utilized in microwave and RF applications. Adapting the well-established design techniques from these fields to the problem of passive radiative cooling can have certain advantages over the existing design approaches in terms of performance and efficiency.

To demonstrate the possibility of such an adaptation, we developed a semi-analytical design method with thin-films of preselected materials based on impedance matching. Although impedance matching with transmission lines is heavily utilized in microwave and RF applications, it has not been adapted to problem of designing optical filters [5,6]. We demonstrate that the proposed method is applicable for designing additional layers that enhance the cooling power of existing thin-film structures. It can be easily applied to any thin-film system to design additional layers for various purposes, e.g. protection or cooling power enhancement, without degrading the optical performance of the existing system. In light of this study, several other impedance matching approaches can be adapted to design various optical structures.

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