

# Stuttgarter Physikalisches Kolloquium

Fachbereich Physik, Universität Stuttgart  
Max-Planck-Institut für Festkörperforschung  
Max-Planck-Institut für Intelligente Systeme

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Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart-Vaihingen

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## Hot Electrons and Hot Plasmons for Photovoltaics

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### Abstract

We will discuss two recently observed phenomena with implications for photovoltaic devices. First, it is well known that conventional silicon solar cells lose a significant fraction of their absorbed energy when electrons that are excited high into the conduction band cool to the band edge. Although colloidal semiconductor nanocrystals (or quantum dots) had been proposed as a route to slow down this cooling so the excess energy of these hot electrons could be captured, no experiments had yet demonstrated this effect. We will describe recent experiments that show the first step of this process - extraction of hot electrons from PbSe quantum dots. Second, we will consider what happens when materials that are patterned on an optical length scale are heated. In this case, the pattern can modify the thermal emission of the material. This effect may lead to efficient thermophotovoltaic devices, which convert heat (from the sun or another source) into electricity. In this context, we will discuss the thermal emission of periodically structured metals. In particular, we examine simple metallic films with surfaces that are patterned with a series of circular concentric grooves (a bull's eye pattern). Due to thermal excitation of surface plasmons, a single beam of light can be emitted from these films in the normal direction that is amazingly narrow, both in terms of its spectrum and its angular divergence. Thus, metallic films can generate highly directional beams of light by a simple thermal process.