RECONFIGURABLE TEMPERATURE CONTROL AT THE MICROSCALE BY LIGHT SHAPING

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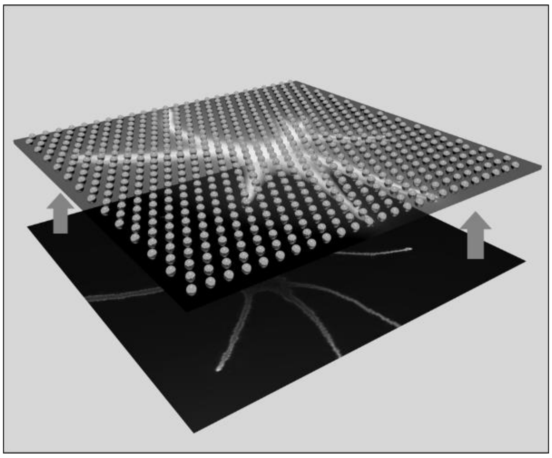

Figure 1: SLM-based projection of an optical pattern calculated to pre-compensate heat diffusion. After photothermal conversion by a gold nanoparticle array, heat diffusion induces the desired 2D temperature repartition.

Temperature is often a critical factor from physics to biology. However, tailoring temperature at the micro-scale is not straightforward since heat diffusion alters temperature patterns. In this study, we propose and demonstrate an accurate and reconfigurable microscale temperature shaping technique by precisely tailoring the illumination intensity that is sent on a homogeneous array of absorbing plasmonic nanoparticles. The method consists in (i) calculating the distribution of heat source, also named Heat Source Density (HSD), which pre-compensates heat diffusion effects [1] so as to produce the desired temperature distribution, and (ii) using a Spatial Light Modulator (SLM) to shape the illumination and reproduce this HSD in the nanoparticle plane. After heat diffusion, the tailored heat source distribution produces the desired microscale temperature pattern under a microscope. The method is validated using wavefront-sensing-based temperature imaging microscopy [2][3]. Fast (sub-ms), accurate and reconfigurable temperature patterns are demonstrated over arbitrarily-shaped regions. In the context of cell biology, we finally present a methodology combining fluorescence imaging with reconfigurable temperature shaping to thermally target a given population of cells or organelles of interest, opening new strategies to locally study their response to thermal activation [4].

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