突破衍射极限：激光烧蚀法制备光学纳米图案和实现近场成像

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德国康斯坦茨大学 Paul Leiderer 教授发表了基于激光烧蚀法制备光学纳米图案和实现近场成像的综述。在光学近场中——在与波长 λ 相当的距离上——电磁场不仅包含传播分量，而且还包含局部的“倏逝”分量，而倏逝分量可以被限定在长度远小于 λ 的尺度上。如果光的强度足够高，它可以在光学近场的局部区域使能量达到一个阈值，使该区域的材料被烧蚀，这使得超越“衍射极限”成为可能。

通过直径为几微米甚至更小的球形透镜阵列，纳米烧蚀能够产生这种近场结构。通过激发金属纳米结构中传导电子产生的等离子激元效应，可以在材料表面上产生更小的烧蚀结构。金 (Au) 由于其优越的等离激元性质而成为这一技术的首选金属。金属纳米颗粒中的等离激元激发可以被限制在比介质球后的纳米喷流更小的尺度内。因此，它们可以产生比球形透镜获得的纳米孔尺寸更小的表面图案。一个常用的例子是时域有限差分 (FDTD) 法。通过纳米烧蚀，我们可以得到等离激元纳米结构实验“接触照片”，并将它们与这些模拟结果进行比较。

综上所述，光学近场纳米烧蚀对于表面图形化制备以及等离激元电子学的应用都具有重要价值。

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Laser oxidation-a new approach to tuning the optical third-order nonlinearity of boron nitride

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The research group of Prof. Paul Leiderer published a review entitled “Optical near-field imaging and nanostructuring by means of laser ablation”.

In the optical near field – at object distances comparable to the wavelength λ – the electromagnetic optical field contains not only propagating, but also localized “evanescent” components, and these can be confined to length scales distinctly smaller than λ. If the intensity of the light is high enough, it can locally reach a threshold in these near-field hotspots where the irradiated material is removed by ablation. Thus, nanostructuring of surfaces well below the “diffraction limit” becomes possible.

A realization of this near-field structuring by nano-ablation is by small, spherical lenses with a size of a few micrometers and below, which are placed directly on the substrate to be structured. Even smaller ablation structures on surfaces can be created by expoiting plasmonic effects which result from the excitation of conduction electrons in metallic nanostructures. A preferred metal for this purpose is gold because of its superior plasmonic properties. Plasmonic excitations in metallic nanoparticles can be confined to length scales even tinier than the photonic nanojets behind dielectric spheres. They thus lend themselves for patterning surfaces with features still smaller than the nanoholes created by spherical lenses.

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