非接触式微球辅助超快激光纳米图案化技术

DOI: 10.12086/oee.2024.241004.h01

基于微球的激光精密工程和光学显微技术能够突破传统光学器件对光的调制极限，提供了一种全新的构建微纳光学系统的思路。对于微球激光精密工程方向的研究，目前所报道的多是在接触模式下实现微纳结构的制备，这极大地限制了微球加工的自由度和应用场景。如何去平衡微球激光精密加工的分辨率及其加工自由度，还有待进一步的探究和解决。

厦门大学及新加坡国立大学洪明辉院士团队，与大连理工大学曹暾教授团队联合报道了一种基于非接触式微球的超快激光纳米图案化技术，在相变材料表面实现了小于 50 nm 的功能化纳米图案。非接触模式下，将微球置于一个特殊设计的夹持器上，通过灵活控制微球 *X-Y-Z* 扫描可以获得纳米级加工结果，此时微球与样品间距在微米量级。通过微球技术和飞秒激光照射，这项新技术能够在多种情形下以非接触模式对更精细的特征结构进行高速加工。

通过理论计算，入射激光经过 50 μm 小球后的聚焦光斑大小虽然仅为 ~ 678 nm。但由于超快激光的非线性效应，包括双光子吸收及顶端阈值效应，使得最后在相变材料表面获得了<50 nm 的结构。这种表面纳米结构是由微球的聚焦效应，超快激光的双光子吸收及顶端阈值效应同时作用形成的。

Opto-Electronic Advances, 2023, **6**(6): 230029.
https://www.oejournal.org/article/doi/10.29026/oea.2023.230029.

Non-contact microsphere ultrafast laser nanopatterning technology

DOI: 10.12086/oee.2024.241004.h01

In addition to nano-hole structures achieved by contact mode, the microsphere femtosecond laser fabrication can also realize arbitrary structures on sample surfaces in non-contact mode. How to achieve a good balance between the working distance and feature size is a vital issue for microsphere assisted laser fabrication.

The research group of Prof. Minghui Hong from Xiamen University and the National University of Singapore, and Prof. Tun Cao from Dalian University of Technology jointly reported an ultrafast laser processing technology based on non-contact microspheres, realizing <50 nm functional nano-patternings on the surface of phase change materials. In non-contact mode, the microsphere is placed on a specially designed holder, and the nano-structures can be obtained by flexibly controlling of microsphere in *x-y-z* scanning. In this case, the distance between the microsphere and the sample is in the order of microns. Via the femtosecond laser irradiation of microsphere, this new technology enables the high speed machining of finer feature nano-structures in non-contact mode in various conditions.

This method provides a new idea for ultrafine laser surface nano-machining, and its machining efficiency and machining freedom are expected to be further improved via microsphere array and microsphere engineering.

Opto-Electronic Advances, 2023, **6**(6): 230029.
https://www.oejournal.org/article/doi/10.29026/oea.2023.230029.