小气泡，大切换：突破衍射极限的偏振切换发射器

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由于自然界材料中光与物质的相互作用较弱，通常的调谐机制带来的折射率改变量很小，要实现等离激元天线辐射场的动态调谐和切换是个巨大挑战。迄今为止，动态可调和、可切换的等离激元天线还未见报道。

北京师范大学陈建军教授课题组提出用激光在水中产生气泡获得大的折射率改变，从而实现超小的偏振可动态切换的等离激元天线发射器。激光诱导气泡类似用火加热水壶烧水产生气泡。当 532 nm 激光聚焦在金膜上时，激光加热金膜。在临界强度以上时，金膜上方的水中出现微米气泡。微米气泡的折射率为 1.0，从而导致金膜表面的折射率改变量可达到 Δn =−0.333，远大于前期基于其它效应的折射率改变量 ($|\Delta n| \leqslant 0.06$)。该课题组在实验上用聚焦离子束技术在金膜表面上制备了两个正交的亚波长纳米槽天线，构成一个超小的表面等离激元发射器 ($\sim 0.4\lambda^2$)。利用激光在水中产生气泡获得大的折射率改变 (Δn = −0.333)，通过改变两个纳米槽天线辐射场的相位差，陈建军教授课题组首次在实验上展示了亚波长等离激元发射器的辐射场的偏振从椭圆偏振态 ($\gamma_{water} \approx 0.20$) 切换到线偏振态 ($\gamma_{bubble} \approx 0.86$)。这个突破衍射极限的偏振可切换发射器能够极大地提高片间光通信的灵活性和容量。

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Small Bubbles Bringing Large Switching: Polarization-Switchable Plasmonic Emitters

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It's difficult to dynamically tune and switch emission polarization states of plasmonic antennas (or emitters) at nanometer scales owing to weak light-matter interactions in natural materials. By now, polarization-switchable plasmonic antennas (or emitters) have not been reported. The research group of Prof. Jianjun Chen from Beijing Normal University propose using a control laser beam to induce a bubble (n=1.0) in water (n=1.333), which is similar to boiling water in a kettle with fire, to obtain a large index variation as high as $|\Delta n|$=0.333, and the emission polarization of an ultra-small plasmonic emitter ($\sim 0.4\lambda^2$) was dynamically switched for the first time, as shown in the work. The plasmonic emitter consisted of two orthogonal subwavelength metallic nanogroove antennas on a metal surface, and the separation of the two antennas is only s_x=120 nm. Because of a large refractive index variation ($|\Delta n|$=0.333), the phase difference (φ) between the emission light from the two antennas was greatly changed when a microbubble emerged in water under a low-intensity control laser. As a result, the emission polarization of the ultra-small plasmonic emitter was dynamically switched from an elliptical polarization state to a linear polarization state, and the change of the degree of linear polarization is as high as $\Delta\gamma \approx 0.66$. This ultra-small polarization-switchable plasmonic emitter might increase flexibilities and communication capacities in inter-chip optical communications and quantum communications.

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