如何通过薄太阳能板捕获所有可用的光子

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材料的折射率 n 决定了光在入射界面上被反射 (R) 或者透射 (T) 的程度。高效率的太阳能技术 (及产品) 总能在总能量 ($A + R + T = 100\%$) 一定的情况下，最大限度地提高太阳光的吸收部分 (A)。

加拿大多伦多大学 Sajeev John 教授和澳大利亚斯威本科技大学纳米实验室的 Saulius Juodkazis 教授联合团队展示了如何通过使用光子晶体 (PhC) 上的周期性图案来进行光捕捉光，从而进一步增强光捕捉以打破光学极限。被捕捉在微米级超薄硅层内的光会产生干涉，光进一步被吸收，从而接近理想的全吸收极限 ($A = 100\ \%$)。重要的是，即使在微米级的薄太阳能板中，干涉和光局域化引起的强吸收也可以增强光捕捉。光子晶体捕捉光的原理适用于其他需要增强光吸收的材料和应用，例如传感器和光催化等广泛应用。大面积激光直写技术展示出空前的、能够打破当前技术限制的潜力，为制造光捕捉表面结构提供解决方案。激光直写在工业上可用于太阳能板的大面积图形制备，并且在室温条件下即可进行。

文章中所提出的光子晶体图案结构可以应用于其他类型的太阳能板表面。研究人员表示，利用这种技术，在数十微米的薄太阳能板上非常有可能实现光捕捉能力的突破。并且这样制造的太阳能板将变得灵活轻便，从而拓宽了在手持、自主、远程、太空等应用中的潜力。

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How to catch all available photons by a thin solar cell?

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Refractive index of material, n, defines how much light is reflected (portion R) and transmitted (portion T) at the interface onto which light is impinging. The art (and business) of high efficiency solar cells is to maximise the absorbed portion A of sun light in the overall energy balance $A+R+T = 100\%$, which implies that no light should be escaping a slab of a solar cell engineered to deliver $R = 0$ and $T = 0$, hence, aiming at a perfect light trapping with $A = 100\%$.

The research groups of Prof. Sajeev John from University of Toronto and Prof. Saulius Juodkazis from Swinburne University of Technology show how to further enhance light trapping beyond the ray optics limit by trapping light with photonic crystal (PhC) periodic patterns. Interference of light which is trapped inside micro-thin Si layer can reach further absorption towards the ideal full absorption limit of $A = 100\%$. Importantly, strong absorption due to interference and light localization enhances light absorption even in micrometers thin solar cells. The principle of PhC light trapping is applicable for other materials and applications where enhancement of light absorption is beneficial, e.g., in wide range of sensors. Large area direct laser writing is shown to deliver solution for fabrication of light trapping surfaces beyond the currently achievable limit. Laser writing is industrially scalable for macroscopically large area patterning of solar cells and can be carried out in the ambient room conditions.

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