高性能光电化学电池可在微重力下裂解水

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《自然-通讯》发表的一项研究Efficient solar hydrogen generation in microgravity environment展示了在接近零重力的情况下，光驱动水裂解产生氢气和氧气。该研究成果或能应用于长期航天飞行，期间可利用水来生产设备用燃料和可呼吸的氧气。



图1：具有实验装置的落塔在自由飞行9.3秒后从减速器中向上提升。图片来源：ZARM Drop Tower Operation and Service Company

植物能够将光和水转化为燃料和氧气。科学家希望模仿和改进这种自然过程，通过人工光合作用大规模利用可再生能源。虽然这项技术在地球应用方面取得了进展，但是尚未有研究探索它在长期航天飞行方面的应用潜力。

美国加州理工学院的Katharina Brinkert及其同事开发了一种高性能的光电化学电池，它们能够在

接近零重力的情况下利用光来裂解水。作者在落塔中开展了一系列实验，模拟太空的近零重力环境，探索如何在太空中实现太阳能水裂解。他们发现缺乏重力会减少光驱动的水裂解活动，因为表面去除的气泡有限。然而，通过调整电池中纳米结构的形状，作者能够促进气泡释放，维持低重力下的水裂解活动。

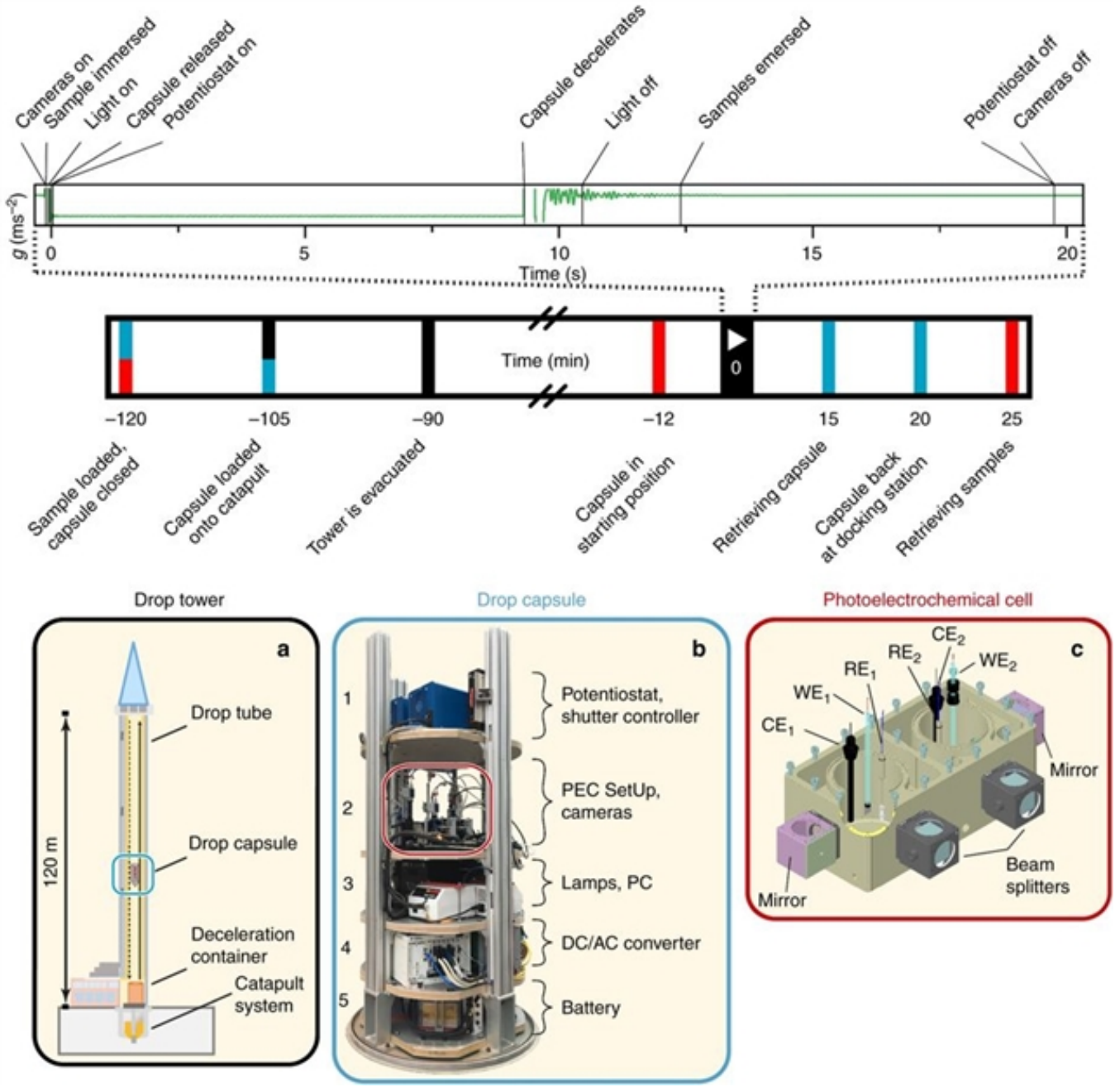


图2：微重力条件下光电化学实验的实验装置和时间线。插图显示了落塔(a)、胶囊设备(b)和光电化学电池(c)。图片来源：Brinkert et al.

作者认为这项技术有望改善和延长长期航天飞行的生命支持系统。该研究也为如何改进地面光驱水裂解装置提供了一种思路。

摘要：Long-term space missions require extra-terrestrial production of storable, renewable energy.

Hydrogen is ascribed a crucial role for transportation, electrical power and oxygen generation. We demonstrate in a series of drop tower experiments that efficient direct hydrogen production can be realized photoelectrochemically in microgravity environment, providing an alternative route to existing life support technologies for space travel. The photoelectrochemical cell consists of an integrated catalyst-functionalized semiconductor system that generates hydrogen with current densities >15 mA/cm2 in the absence of buoyancy. Conditions are described adverting the resulting formation of ion transport blocking froth layers on the photoelectrodes. The current limiting factors were overcome by controlling the micro- and nanotopography of the Rh electrocatalyst using shadow nanosphere lithography. The behaviour of the applied system in terrestrial and microgravity environment is simulated using a kinetic transport model. Differences observed for varied catalyst topography are elucidated, enabling future photoelectrode designs for use in reduced gravity environments.

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