molecular modulator to each motor unit. The modulator and the motor can be operated independently using light of different wavelengths. Under the operating wavelength of a molecular motor (λ = 312–365 nm), the rotors braid the polymer chains resulting in a macroscopic contraction (Fig. 2c, braiding). Switching to a longer wavelength (λ > 400 nm), the rotors stop rotating and the modulators undergo a ring-opening reaction (Fig. 2c, unbraiding). In this configuration, the two aromatic groups of the modulator can freely rotate along carbon–carbon single bonds (Fig. 2c, centre). As a consequence, the potential energy initially stored in the braided polymer chains drive the modulator to rotate in a direction that is thermodynamically downhill, therefore unbraiding the polymer chains. Macroscopically, the contracted organogel recovers its original volume and completes a full work circle.

It is worth noting that the braiding (or contraction) event takes place even as both molecular machinery parts are in operation since the motor operates at a higher frequency than the modulator. This is yet another analogy to a working automatic mechanical watch, where the motion of the wearer's arm — like the high-frequency rotating motors — can keep winding the mainspring, therefore keeping the watch running without pause. Aside from achieving a complete macroscopic mechanical cycle driven by nanomachines, the work of Foy *et al.* demonstrates, perhaps more strikingly, a general pathway to release the energy collected in a ratchet motion and repetitively perform work in out-of-equilibrium conditions. ❐

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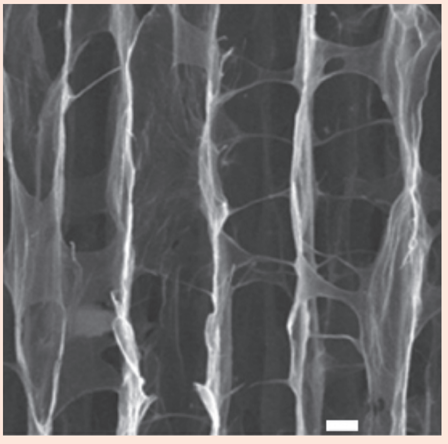
WATER REMEDIATION

A steam nanogenerator

The virtually infinite reservoirs offered by seas and oceans give hope for a solution to the scarcity of clean water — one of the most serious current challenges worldwide, projected to become even more critical as years go by. Such a wide issue can naturally be tackled from different angles, the better use of our current resources being a relevant example to which everyone can contribute. Simultaneously, researchers constantly look for more and more effective purification processes, such as desalination and the removal of pollutants, to increase the amount of available water.

Evaporation is a natural solution to detach water from unwanted contaminants effectively, and thermal processes have been widely exploited in the past for this aim. However, unsustainable energy consumption and, in turn, additional pollution usually emerge as unavoidable and unacceptable side effects — calling for alternative, more efficient approaches. Simultaneously, a versatile method capable of preserving high efficiencies in extreme environments as various as seawater, brackish groundwater and even industrial wastewater is intensively sought.

Now, Panpan Zhang *et al.* (*ACS Nano* http://doi.org/b66c; 2017) report on the use of graphene-based membranes to generate clean water by efficiently exploiting solar thermal energy. The researchers thermally treat an ethanol-mediated suspension of graphene oxide by exploiting freeze-casting, freeze-drying and thermal annealing processes. As a result, they obtain long-range ordered assemblies of vertically aligned graphene sheets bridged by twisted carbon fibres, with controlled overall thickness in the millimetre range and displaying advantageous mechanical properties. The structure of a typical sample is shown (scale bar 10 μm), visualized by means of scanning electron microscopy.



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The researchers examine the thermal behaviour of the fabricated devices under different illumination conditions, confirming the exceptional absorbance of graphene oxide over a spectral region ranging from ultraviolet to infrared. When in contact with water, elevated rates of evaporation ~1.2 kg m^{-2} h^{-1} are induced under one-sun illumination. This is possible in view of solar thermal conversion efficiencies ~85% and of the high temperatures achieved in turn. However, another crucial property is the geometrical structure of the device, facilitating the escape of steam through the ~30-μm-wide interlayer spaces. The relevance of this latter aspect is confirmed by the lower efficiencies reported for non-structured graphene-oxide-based films and foams.

The researchers test the device in seawater and in various acidic and basic solutions, demonstrating that the produced steam is neutral, effectively desalinated and purified from metal ions. Moreover, they discuss several ways to improve the device performance even further. In particular, they demonstrate that the characteristic evaporation rates can be enhanced to ~1.6 kg m^{-2} h^{-1} after O_2-plasma treatment, changing the character of the as-fabricated device from hydrophobic to hydrophilic and improving its contact with water, in turn. The energy transfer within the device can also be made more efficient by introducing a thermally insulating layer preventing dissipation in bulk water.

GIACOMO PRANDO