depends on the ratio of the Fano resonance absorption to the bending amplitude of the bilayer, $\delta A/\delta x$. Zhu and colleagues reveal in particular that depending on the Fano resonance detuning, the optomechanical parameter $\delta A/\delta x$ can change its sign: it is positive when the pump laser frequency, ω_L, is red-detuned with respect to the Fano resonance, ω_0, that is, $\omega_L - \omega_0 < 0$, or it is negative when the pump laser is blue-detuned, that is, $\omega_L - \omega_0 > 0$. By developing a complete model in which three nonlinear coupled equations describing acoustic, optical and the thermal fields are taken into account, the authors have shown that the ratio $\delta A/\delta x$ contributes to the effective damping term in the out-of-plane mechanical motion equation of the bilayer membrane. This damping, different in nature from the classical anharmonic oscillator damping, comes from the delayed thermoelastic response of the bilayer membrane. The thermoelastic force, in fact, depends on the thermal heat flow, which is not instantaneous, and there is a delayed response leading to a mechanical frictional force $F = -(\delta A/\delta x)v(t)$, where $v(t)$ is the out-of-plane velocity of the bilayer membrane. Consequently, when $\delta A/\delta x$ is positive, the mechanical damping is positive and the cooling regime is achieved (case of the red Fano detuning obtained with an incident pump wavelength of 1,550 nm in Fig. 1b). On the other hand, when $\delta A/\delta x$ is negative, mechanical amplification is obtained. These two regimes can be achieved for optical continuous-wave radiation of a given wavelength, simply by tuning the bias-dependent Fano resonance to be either in the red (case of the pump wavelength of 1,550 nm shown in Fig. 1b) or blue Fano detuning situation.

As a demonstration of the efficient optomechanical back-action process, the cooling and amplification have been explored in detail and an optomechanical coupling strength of $d\omega_0/dx = -340$ GHz nm^{-1} was measured. The authors have shown that cooling could be achieved down to 48 K from room temperature. In the amplification regime, the authors have shown a threshold phenomenon in which amplification occurs over four decades of the mechanical power in the coherently oscillating fundamental mechanical mode, which is remarkable. Moreover, the authors observe that the mechanical resonance linewidth narrows under this parametric amplification, which is similar to what we can expect in a saser regime (acoustic phonon laser based on a nonlinear three-phonon process driven by lattice anharmonicity).

Zhu and colleagues' findings provide new perspectives in optomechanics as the thermoelastic process (heating) is among the simplest and most common way to induce strain with light in an absorbing medium. Their devices work at a relatively low frequency (200 kHz), but reaching the GHz–THz regime could provide a path towards applications such as high-speed acousto-optic light modulation for telecommunication technologies. The work of Zhu *et al.* shows that the exploration of different light–matter coupling mechanisms in optomechanics is a route worth taking. Indeed, many exciting directions remain unexplored, including, for example, inverse piezoelectrics in ferroelectric membranes or light-controlled flexoelectricity[7]. ❒

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DIGITAL HOLOGRAPHY

Noise-free images

Digital holography is employed in applications including 3D displays, non-destructive testing, cryptography and homeland security. However, the quality of digital holograms is usually degraded by both laser speckle, due to the coherent nature of the laser sources used, and incoherent additive noise. Vittorio Bianco and co-workers in Italy and the USA have now proposed a scheme to achieve quasi-noise-free digital holography reconstructions by employing a combination of noise-reduction techniques (*Light Sci. Appl.* **5,** e16142; 2016). The result is the generation of high-quality holographic images with greatly reduced noise (pictured).

The noise reduction consists of two steps. The first is an enhanced grouping algorithm that groups image fragments similar to a given reference and provides noisy groups as an output. The second step is sparsity enhancement filtering by which each image fragment is used to filter the entire group.

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Holographic images of a matryoshka doll (40 mm high, 22 mm wide) were processed by the proposed method (right). The doll was illuminated by two lasers emitting at the wavelengths of 532 nm and 632.8 nm to capture the green and red components, respectively, of its appearance. Both the laser beams were superposed and took the same optical paths for both the reference and the object beams. The object beams were scattered by a rotating diffuser in front of the doll.

The holograms corresponding to the two-colour components were separately processed and synthesized by a spatial correlation coefficient maximization approach. When the holographic reconstruction was processed by conventional means, the coherent speckle noise was still apparent (left), whereas the noise-reduced version (right) is of greatly improved quality and contrast with comparable resolution.

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