Macroscopic motion from synchronized molecular power strokes

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Artificial molecular machines performing mechanically relevant motion such as molecular motors and switches have been integrated in liquid crystals and supramolecular systems successfully, to yield motion at macroscopic scale.[1,2,3] Yet, so far, the macroscopic response of these anisotropic materials has failed to mirror the complexity of the molecular movement, like e.g. rotation of molecular motors, and essentially the soft materials that were produced were switchable materials.[4,5] Here, we show how molecular motors can be interfaced with liquid crystal polymer networks to yield true mechanized materials that demonstrate oscillatory behavior (repeated swaying motion).[6] The operating design includes buildup and release of mechanical strain in the polymer originating from synchronized power strokes of molecular motors mirroring their cyclic operation. Delicate balance between motor rotation frequency and viscoelastic properties of polymer network allows effective synchronization avoiding the establishment of a photo-stationary composition. The results demonstrate that each step of molecular rotation cycle can be expressed at macroscopic scale. Our findings bring the field closer to continuous operation of materials and their autonomy which is a blueprint of a new generation of smart materials.

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