

Supplementary Materials for **Addressable metasurfaces for dynamic holography and optical information encryption**

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Published 15 June 2018, *Sci. Adv.* **4**, eaar6768 (2018)

DOI: 10.1126/sciadv.aar6768

The PDF file includes:

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- fig. S3. High quality and high resolution of the holographic patterns.
- fig. S4. Principle of the multiplexed metasurfaces.
- fig. S5. Reconstructed holographic patterns in different zones upon LCP, RCP, or LP light illumination.
- References (31–35)

Other Supplementary Material for this manuscript includes the following:

(available at advances.sciencemag.org/cgi/content/full/4/6/eaar6768/DC1)

- movie S1 (.avi format). Evolution of the metasurface hologram with static and dynamic patterns.
- movie S2 (.avi format). Evolution of the metasurface hologram with sequenced dynamics.
- movie S3 (.avi format). Dynamic transformation among different numbers.

Supplementary Materials

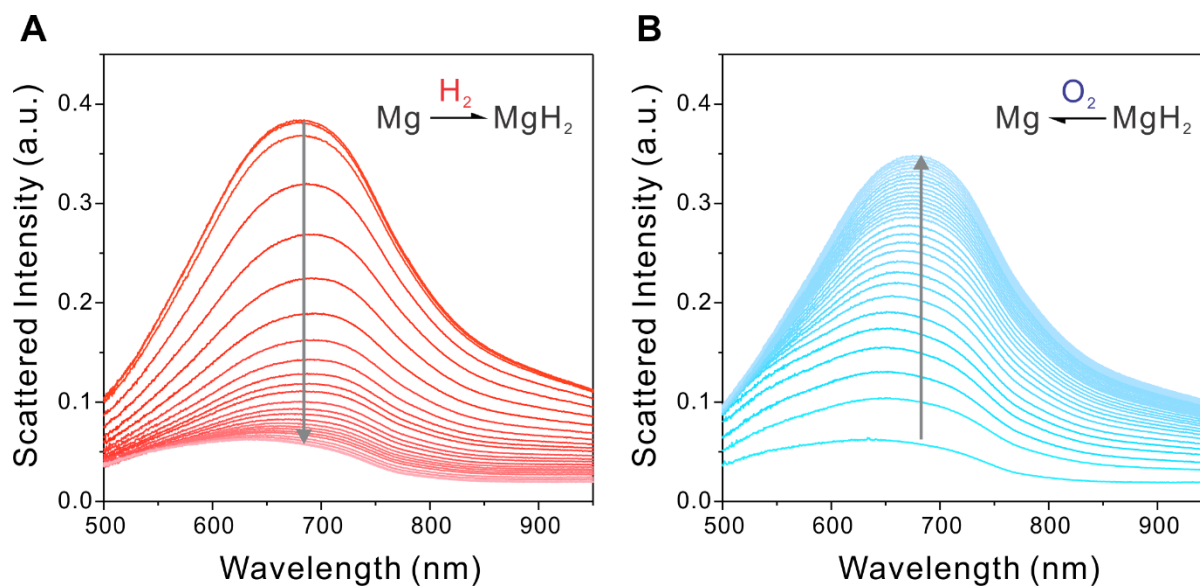


fig. S1. Dynamic scattering spectra of a Mg nanorod during hydrogenation and dehydrogenation. Representative dynamic scattering spectra of an Mg nanorod recorded during hydrogenation (A) and dehydrogenation (B).

In the hydrogenation process, a hydrogen molecule is catalytically split into two hydrogen atoms at the Pd surface(23), which subsequently diffuse into the Mg nanorod, undergoing the transition to the hydride state. The dehydrogenation process involves binding of oxygen with the desorbed hydrogen atoms from the hydride to form water. This avoids a buildup of hydrogen at the Pd surface, thus facilitating hydrogen desorption(31, 32). The sidewalls of the nanorods are oxidized to MgO after fabrication. Hydrogen is absorbed or desorbed through Pd at the top of the nanorods. Pd also protects the top of the nanorods from oxidization.

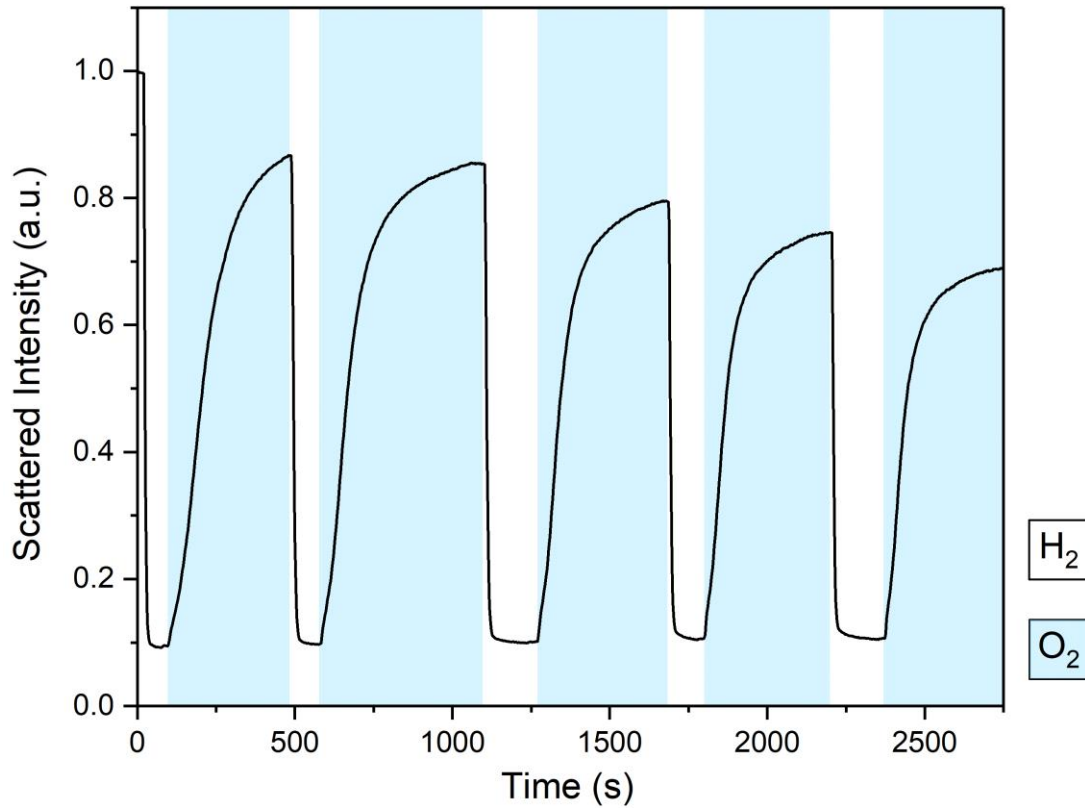


fig. S2. Time evolution of P₁ during hydrogenation and dehydrogenation in multicycles. The scattered intensity at the resonance peak position of P₁ is used to track the dynamic processes.

The reversibility and durability of the metasurface can be further improved through careful material engineering and optimizations using Mg alloys for achieving robust switching up to 10,000 cycles(33) as well as using a polytetrafluoroethylene (teflon) protective layer(34, 35) for avoiding water staining.

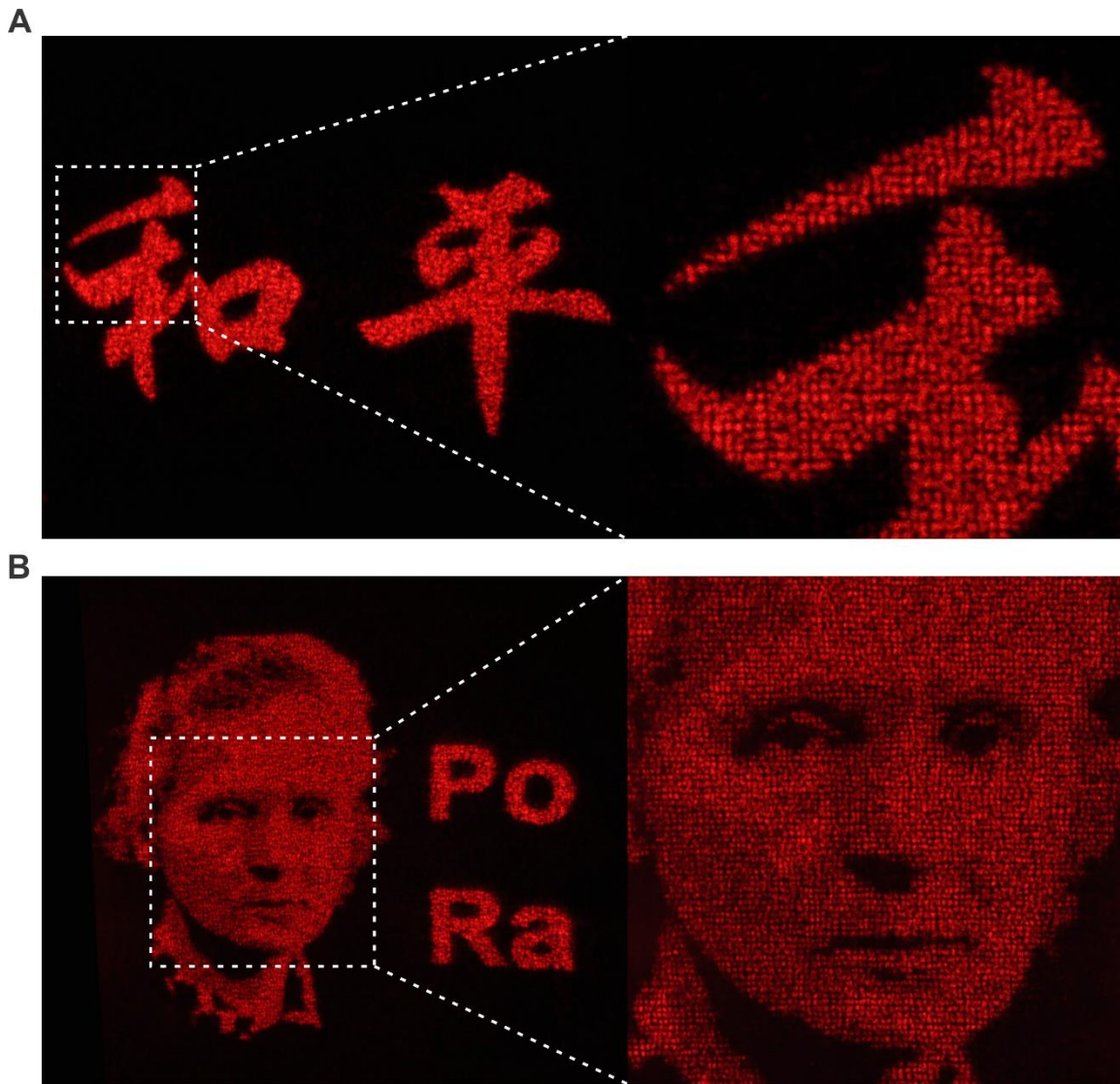


fig. S3. High quality and high resolution of the holographic patterns. (A) Enlarged view of the Chinese letter ‘harmony’. (B) Enlarged view of the Marie curie portrait.

The enlarged views in fig. S3 demonstrate high quality and high resolution of the reconstructed holographic patterns. The 2×2 pattern holograms were designed based on the concept of Dammann gratings to avoid formation of laser speckles and thus to improve the image fidelity. Current designs can be further optimized using an $N \times N$ (N is an integer) Dammann grating design.

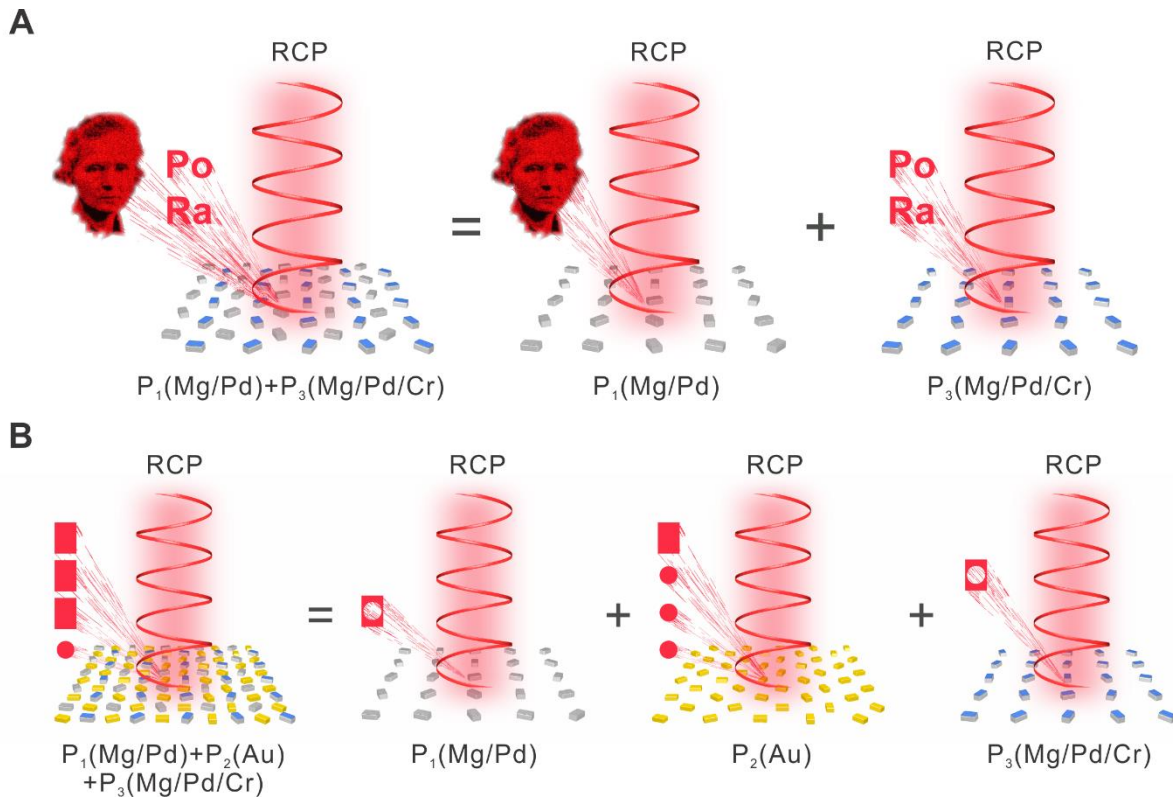


fig. S4. Principle of the multiplexed metasurfaces. (A) Two holographic patterns reconstructed from two independent phase profiles containing Mg/Pd (P_1) and Mg/Pd/Cr (P_3) nanorods as dynamic pixels, respectively. (B) Three holographic patterns reconstructed from three independent phase profiles containing Mg/Pd (P_1), Au (P_2) and Mg/Pd/Cr (P_3) nanorods as pixels, respectively.

As shown in fig. S5, A and B, a reconstructed pattern occurs in zone II upon illumination of the RCP light, whereas its centrosymmetric counterpart occurs in zone I upon illumination of the LCP light. Upon illumination of the LP light, the two patterns with the same intensity appear simultaneously in Zone I and Zone II, respectively.

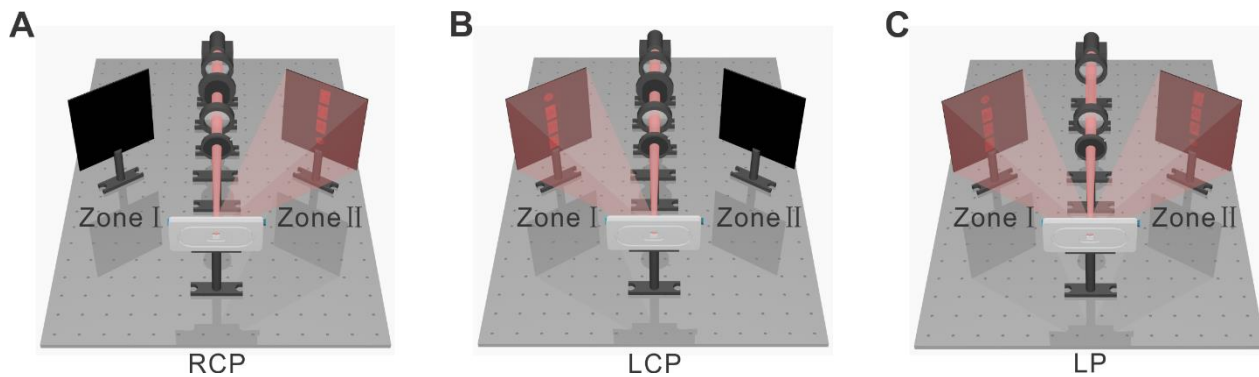


fig. S5. Reconstructed holographic patterns in different zones upon LCP, RCP, or LP light. Reconstructed holographic patterns upon the RCP (A), LCP (B), and LP (C) light illumination in different zones.

Movies S1 to S3.