Devices, Systems and Methods for Ultrafast Optical Applications (#6221)

Devices including a nonlinear optical mirror that provides stronger modulations of the reflectance or transmittance in the visible and near-infrared spectral ranges

Georgia Tech inventors have developed devices, systems, and methods for ultra-fast optical applications. The devices include a nonlinear optical mirror that provides stronger modulations of the reflectance or transmittance in the visible and near-infrared spectral ranges. The approach utilizes metal-dielectric thin-film structures comprised of noble metals such as gold, silver, and copper. Bilayer metallic thin films of the noble metals can be tuned by controlling the mass-thickness ratio between the metals thereby optimizing the nonlinear optical properties. The metal layers are engineered for linear absorption within a nano-structure. This is necessary because the nonlinear optical response of noble metals arises from the electron and lattice heating caused by the absorption of energy from an ultra-fast optical pulse.

Benefits/Advantages

- Enables the design of an ultrafast all-optical shutter technology in the visible spectral range
- Amplifies the strong and ultrafast nonlinear optical response of noble metal thin films
- Requires lower pump energies than conventional nonlinear optical materials or devices

Potential Commercial Applications

- Ultrafast all-optical shutter
- Ultrafast framing camera
- Pulse shaping device
- Biomedical and micromachining applications
- Short electron, X-ray pulse generations
- Ultrafast photography

Background/Context for This Invention

Materials with strong power-dependent reflectance, absorptance, or transmittance are critical in the development in applications such as optical signal processing, pulse compression, passive protective devices and medical image processing. In the design of materials, there is a tradeoff that exists between the strength of the material and the transparency. In addition, the nonlinear optical response of a material is strong when the optical field resonates with the frequency of an allowed electronic transition, but this leads to long-lived excitations that are much slower than electronic processes that induce a nonlinear polarization, resulting in nonlinear optical devices that are easily implemented in the near-infrared and
infrared spectral ranges. However, there is a strong market need for improved materials that operate at visible wavelengths due to the rapid growth in applications that require ultrafast optical pulses in the visible spectral range.

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