Crystalline supermirrors enhance spectroscopy for improved chemical kinetics understanding

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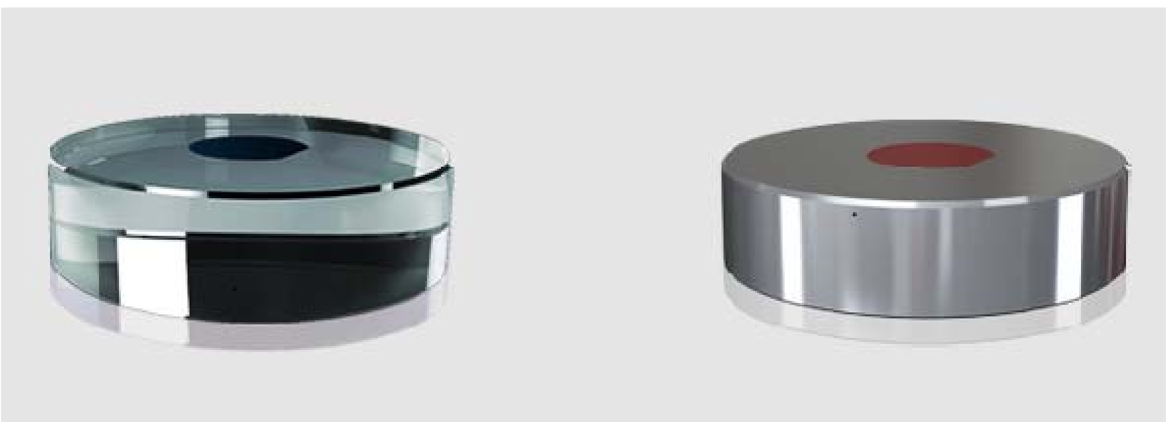

IMAGE: Crystalline Mirror Solutions (CMS) provides crystalline coatings that improve performance in a variety of different optical applications. Products include xtal stable (left) for sub-Hz-linewidth lasers and gyroscopes, and xtal mir (right) is for trace gas detection and novel laser designs. (Image credit: CMS)

Mid-infrared (mid-IR) optical coatings developed by Crystalline Mirror Solutions (CMS; Vienna, Austria) have enabled improved understanding of key processes important to combustion and atmospheric chemistry. Published in the October 28, 2016 issue of *Science* as part of a collaboration including researchers from JILA (a joint institute of NIST and the University of

Colorado Boulder) and the California Institute of Technology (Caltech; Pasadena, CA), the mirrors manufactured by CMS were used to study an elusive short-lived intermediate compound that is crucial for processes relevant to earth and planetary sciences, the burning of fossil fuels, as well as the impact of such reactions on our environment.

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In these experiments, researchers from Jun Ye's group at JILA exploited mid-infrared direct frequency comb spectroscopy, using an enhancement cavity with 3.7 μm crystalline supermirrors provided CMS, in order to probe the reaction kinetics of the deuterated hydroxyl molecule, OD, and carbon monoxide, CO. Here, OD, the heavy hydrogen analog of the hydroxyl molecule, OH, was used as a substitute in order to avoid the masking effects of atmospheric water vapor. The ultimate aim was to realize a fuller understanding of the OH+CO reaction. Given their impressively low levels of optical losses when compared with evaporated or sputtered multilayers, the semiconductor-based single-crystal supermirrors supplied by CMS enabled a tenfold enhancement in the detection sensitivity of this cutting-edge spectroscopy experiment, allowing for the first direct observation of trans-DOCO under thermal reaction conditions.

Ultimately, this work shows the potential for real-time studies of chemical kinetics via direct frequency comb spectroscopy, allowing for a significant improvement in the understanding of this key reaction, and paving the way for better models of the formation of air pollution, achieving ever-more efficient combustion, as well as an in-depth understanding of atmospheric reactions relevant to green-house gas production and climate change. From the perspective of CMS, this experiment confirms that our mid-infrared coating technology is redefining the metrics of high-performance optics in this rapidly evolving wavelength window, the so-called “fingerprint” region for optical gas sensing. Future efforts will involve pushing the limits of the achievable center wavelength of our mirrors to 5 μm and beyond, as well as efforts to enhance the bandwidth of these novel low-loss reflectors.

CMS is a spin-off of the University of Vienna and the Vienna Center for Quantum Science and Technology. CMS was established in Vienna, Austria in 2013 and has since expanded to include sites in Santa Barbara, CA and Zurich, Switzerland. Crystalline supermirrors are a proprietary technology pioneered by CMS and protected by international patents. The application space of our novel coating technology spans optical components for ultraprecise optical clocks, precision interferometry, spectroscopy, as well as solutions for thermal management in high-power lasers and laser machining systems. CMS has received a number of high-profile technology awards such as the Leibinger Innovation Award and the AMA Innovation Award, as well as various national and international start-up prizes. The mid-infrared supermirror technology developed by CMS and used in these efforts is supported by the Defense Advanced Research Projects Agency (DARPA) and the Austria Wirtschaftsservice (aws).

SOURCE: Crystalline Mirror Solutions; http://www.crystallinemirrors.com/news/