

## APPLICATIONS OF CAVITY-ENHANCED DIRECT FREQUENCY COMB SPECTROSCOPY

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Cavity-enhanced direct frequency comb spectroscopy (CE-DFCS) is a unique technique that provides broad bandwidth, high resolution, and ultra-high detection sensitivities.<sup>a,b</sup> This is accomplished by combining a femtosecond laser based optical frequency comb with an enhancement cavity and a broadband, multichannel imaging system. These systems are capable of simultaneously recording many terahertz of spectral bandwidth with sub-gigahertz resolution and absorption sensitivities of  $1 \times 10^{-7} \text{ cm}^{-1} \text{ Hz}^{-1/2}$ . In addition, the ultrashort pulses enable efficient nonlinear processes, which makes it possible to reach spectral regions that are difficult to access with conventional laser sources. We will present an application of CE-DFCS for trace impurity detection in the semiconductor processing gas arsine near  $1.8 \mu\text{m}$  and the development of a high-power, mid-infrared frequency comb<sup>c</sup> for breath analysis in the  $2.8\text{-}4.8 \mu\text{m}$  region.

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<sup>a</sup>M. J. Thorpe, K. D. Moll, R. J. Jones, B. Safdi, and J. Ye. *Science* **311**, 1595-1599 (2006)

<sup>b</sup>F. Adler, M. J. Thorpe, K. C. Cossel, and J. Ye. *Annu. Rev. Anal. Chem.* **3**, 175-205 (2010)

<sup>c</sup>F. Adler, K. C. Cossel, M. J. Thorpe, I. Hartl, M. E. Fermann, and J. Ye. *Opt. Lett.* **34**, 1330-1332 (2009)