Siderite spin transition probed by optical spectroscopy in a laser-heated diamond anvil cell

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Probing optical properties at high pressure and temperature conditions is an important ingredient for constructing an accuate model of the mantle's thermal conductivity. The entire pressure range of the lower mantle is accessible via diamond anvil cell (DAC) experiments, however, resistive heating provides access to only T<1000 K. On the other hand, laser-heated DAC are routinely used to heat samples to T>2000 K, but optical measurements are difficult because of the thermal radiation emitted by the hot sample. In this work, we have used a supercontinum laser source and an intensified CCD camera to measure optical absorption of siderite at T=900-1600 K. Synchronously gating the CCD with the supercontinum pulses allowed diminishing thermal background to ~$8.3*10^{-4}$.

Siderite, $FeCO_3$, has a spin transition at 44 GPa (300 K). In the low spin (LS) state, siderite has an intense crystal field absoprtion band, while this band in the high spin (HS) state is weak[1]; thus, the temperature-induced LS to HS transition at P>44 GPa should be easily accessable, making siderite a good sample choice for pilot experiments.

Expectedly, siderite absorption spectra at 45 GPa and T=1200 K show the LS to HS transformation has completed. At 62 GPa and T=1000 K the spectrum is typical of the LS siderite; at 1200 K the spectrum has features of both LS and HS states; at 1600 K the spectrum shows a full conversion to the HS siderite. Spectra collected at 1070, 1275, and 1480 K and 85 GPa are characteristic of the LS siderite. The probed spin states are consistent with the siderite spin phase diagram[2]. Overall, this is the first report of succesful optical absorption measurements in a laser-heated DAC.

[1] S. S. Lobanov, A. F. Goncharov, and K. D. Litasov, **100,** http://dx.doi.org/10.2138/am (2015). [2] J. Liu, J. F. Lin, Z. Mao, and V. B. Prakapenka, *Am Mineral* **99,** 84 (2014).