A waveguide-based flexible CO2 laser heating system

Hauke Marquardt*[1], Alexander Kurnosov[1], Leonid Dubrovsinky[1], and Vasily Potapkin[2]

[1]Bayerisches Geoinstitut, University of Bayreuth (BGI) – Bayerisches Geoinstitut Universität Bayreuth 95440 Bayreuth, Germany

[2]Universität Münster – Germany

Abstract

The laser-heated diamond-anvil cell (DAC) allows for simulating the pressure/temperature conditions of the Earth mantle and has been extensively used in conjunction with laboratory probes and synchrotron-based methods to make in-situ measurements of physical properties of mantle materials. Based on recent developments regarding the availability of compact high-power fibre lasers emitting radiation with a wavelength of about 1 μm, compact "portable" laser heating systems have been developed that drastically simplified the application of laser-heating and opened the perspective for new type of experiments. However, many (mantle) minerals only weakly absorb laser radiation with 1 μm wavelength. In addition, inhomogeneous distribution of iron (clustering), that is mostly causing laser absorption, may lead to substantial spatial variations in sample temperature. CO2 laser-heating (10μm wavelength) overcomes most of these problems, but, in absence of available fibre optics, its application has been restricted to (few) stationary heating setups. The recent availability of 10 μm wavelength transmitting waveguides opens the possibility to design flexible CO2 laser heating systems that can be conveniently used in combination with a variety of experimental probes. Here we present results of test experiments, where a fan-cooled CO2 laser was coupled to a commercially available Hollow Silica Core Waveguide. In addition to the transmitted laser radiation, visible laser light is transmitted in the cladding of the fibre and serves as a visible guide beam during laser alignment. We will discuss results of different experiments to heat metals and oxides both in air and in diamond-anvil cells. In the future, we plan to integrate both the visualization and the temperature measurement optics into the cage-based system in order to construct a fully self-standing flexible CO2 heating system, offering unique perspectives for future experimental research using diamond-anvil cells both in laboratory environments and at synchrotron facilities.

*Speaker