Laser heating, interfaced with the diamond anvil cell (DAC) pressure generation technique, is a unique tool that allows experimental replication of the conditions of the deep Earth’s interior. A unique on-line CO$_2$ (10 micron wavelength) laser heating system has been designed and constructed at GSECARS, Sector 13 of Advanced Photon Source. The system is integrated into the existing fiber laser based setup (1 micron wavelength), and provides several advantages, including being able to directly heat materials that are transparent to near infrared laser light. The technical aspects of the heating system are presented, including the overall design, power control, switch between NIR and CO$_2$ laser heating, sample alignment, temperature measurements, and monitoring of the heating process. X-ray diffraction measurements of silicates in DAC at high pressures and temperatures using the developed setup are presented. Installation of CO$_2$ laser heating system at Sector 13 (APS) is supported by COMPRES and GSECARS.

**On-line laser heating setup: key features**

- Integrated into existing NIR (~1 μm wavelength) laser heating setup
- Compact design
- Quick switch between the NIR and CO$_2$ laser heating

**Optic scheme for the CO$_2$ laser, X-ray and temperature measurements paths**

- Simultaneous on-line sample monitoring in IR (7.5-13.5 μm) and visible wavelength range

**Heating of transparent to NIR light materials**

**Example of CO$_2$ laser heating**

**Sample in the DAC**

**Spot size of the focused beam ~ 50 μm**

**Comprehensive laser heating setup is one of the important components defining versatility of high-pressure/high-temperature studies at GSECARS**