Comparative study of the influence of pulsed and continuous wave laser heating on the mobilization of carbon and its chemical reaction with iron in a diamond anvil cell

Laser heating in a diamond anvil cell (DAC) is a common method for studying material behavior at high-pressure and high-temperature conditions. It has been previously proven that during continuous wave (CW) laser heating of a sample, carbon of the diamond anvils is mobilized, and its diffusion into the sample can lead to undesirable chemical reactions, which, if not detected, may cause misinterpretations of the results of the experiment. Minimizing the heating time with the use of a pulsed laser (PL) is thought to reduce the risk of possible carbon contamination of the sample; however, this has not been proven experimentally. Here, we report the results of our comparative study of the effect of pulsed and continuous wave (CW) laser heating on the mobilization of carbon and its chemical interaction with iron in a diamond anvil cell. Using X-ray absorption near edge structure spectroscopy, Synchrotron Mössbauer Source spectroscopy, and Synchrotron X-ray diffraction, we examined iron samples that were laser heated in DACs in various pressure transmitting media (neon, argon, and potassium chloride). According to our results, the use of the PL heating does not prevent the sample from carbon contamination. A reaction between carbon and iron happens within a few seconds even at moderate temperatures. We found that one analytical technique was generally insufficient to fully characterize the phase composition of the laser-heated samples.