Supplemental Material to the article
"Laser action occurring as a result of the explosion of porous silicon"

1. The schematic of the experimental setup. To ignite the composites, a single 20-ns pulse of Nd:YAG laser (Quanta-Ray GCR-130, Spectra-Physics, USA) with the wavelength of 1064 nm was transformed into the second and the third harmonics in DKDP crystal and focused on a sample using a lens with a focus distance of 40 cm. Detection included registration of the time-dependent intensity of a light flash emitted under explosion, its spectrum, and image, as well as the recoil pulse accompanying the explosive reaction. Three FD-7K photodiodes (PDs) at angles 45° (PD2), 90° (PD3), and 180° (PD4) to the optical axis detected the flash intensity. A spectrometer (ASP-150TF, Avesta Project Ltd., Russia) with a fiber-optic input recorded the panoramic spectrum in the range of 185–1110 nm during a 10-ms exposure time. The explosion flash image was captured by a CCD camera (C8484-05G02, Hamamatsu, Japan) with an external synchronization option. A piezoelectric sensor (6528101, Imasonic Inc., Besancon, France) measured the recoil impulse. The flash images were post-processed through HiPic 8 software. An additional FD-7K photodiode (PD1) time-synchronized the spectrometer and the CCD camera and triggered oscilloscopes (TDS 3032, Tektronix, USA or WaveSurfer 3054, Teledyne LeCroy, USA). The experimental setup is schematically drawn in Fig. S1.

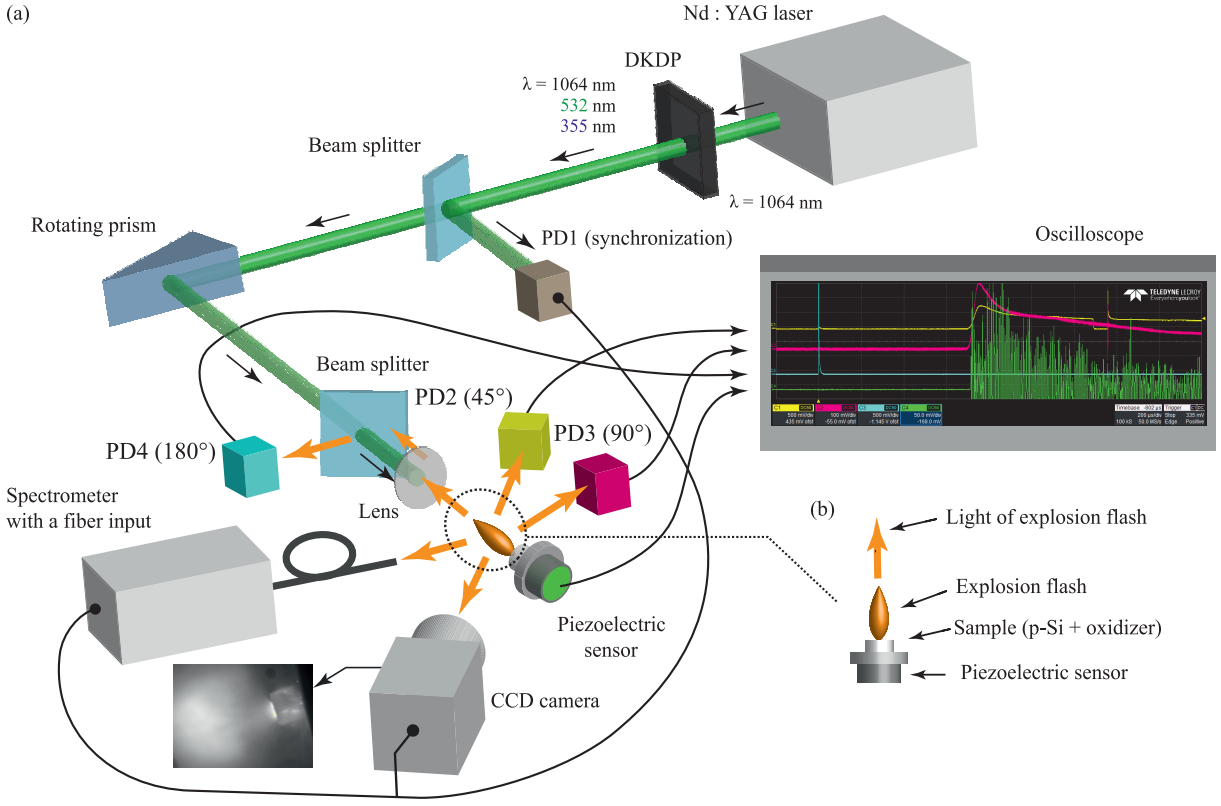

Fig. S1. (a) – Initiation and detection of the explosive reaction of composites based on porous silicon (p-Si) and an oxidizer. Photodiodes (PD), denoted as PD2, PD3, and PD4, detect flash intensity at angles 45°, 90°, and 180° to the optical axis. PD1 time-synchronizes the spectrometer and the CCD camera and triggers the oscilloscope. Piezoelectric sensor (pzs) measures the mechanical recoil impulse. (b) – The target is a sample being the composite p-Si + oxidizer in a polytetrafluoroethylene cap

2. Registration of "zero shelves" with different durations.

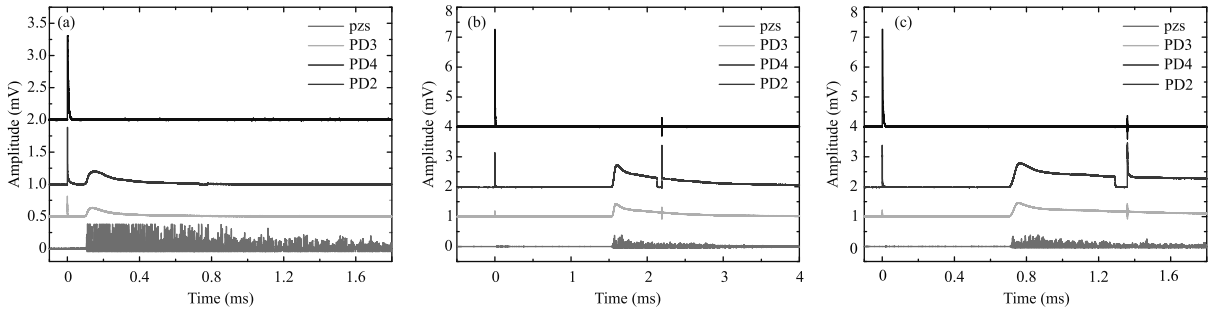

Fig. S2. Time dependence of explosion flash intensity of porous-silicon-based composites. The duration of "zero shelf" approximately equals 42 μs (a), 55 μs (b), and 63 μs (c). Fig. S2c is Fig. 2d from the main text of the article

3. Summary of "zero shelf" registration results.

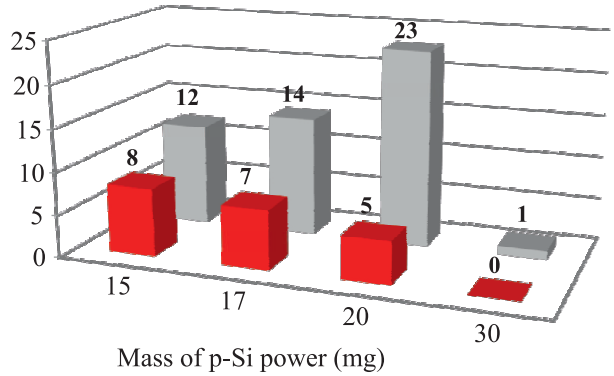

Fig. S3. Bar graph showing the sensitivity of "zero shelf" appearing in time-dependent light flash intensity to the change of p-Si powder mass in a composite. The grey-colored bar represents the number of samples, and the red-colored bar represents the number of "zero shelf" observations for composites with different masses of p-Si powder

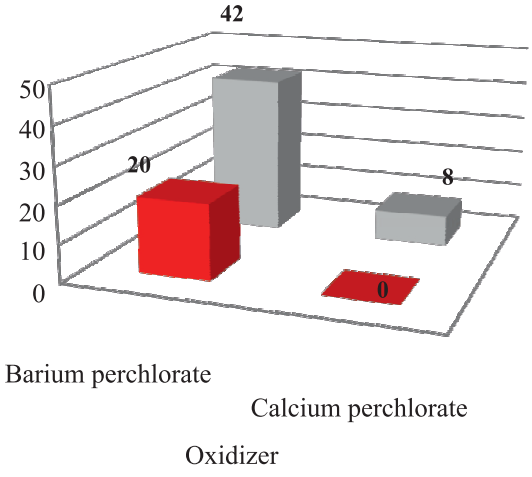

Fig. S4. Bar graph demonstrating the effect of oxidizer choice on "zero shelf" appearance in a time-dependent flash intensity. The grey-colored bar represents the number of samples, and the red-colored bar represents the number of "zero shelf" observations for composites with different oxidizers

4. Explosion flashes spectra of porous-silicon-based composites.

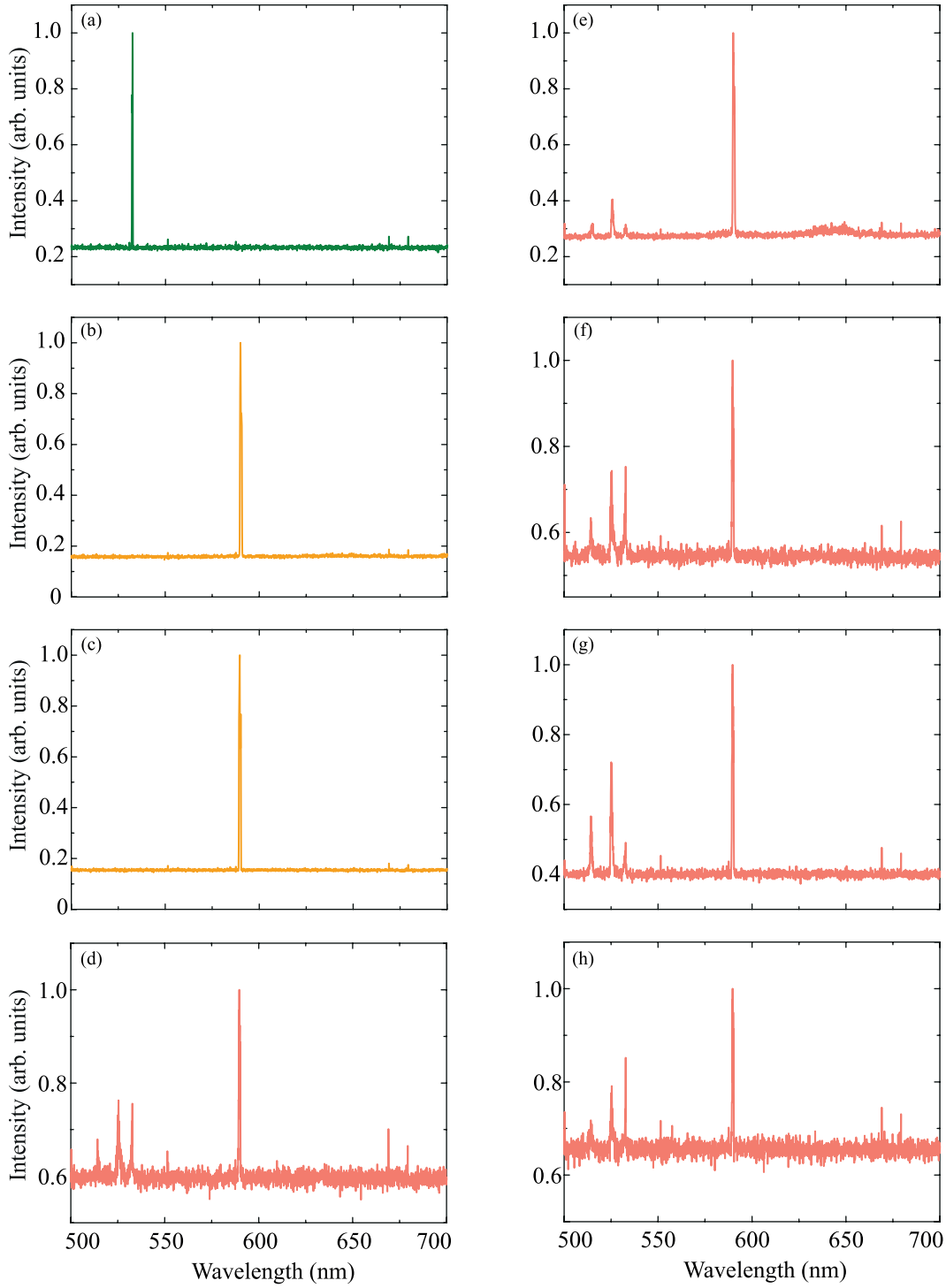

Fig. S5. (a) – The second harmonic 532 nm of the initiating Nd : YAG laser (Quanta-Ray GCR-130, Spectra-Physics, USA). (b), (c) – Explosion flashes spectra of samples porous silicon + calcium perchlorate. (d)–(h) – Explosion flashes spectra of samples porous silicon + barium perchlorate. The full widths at half maximum of the spectral lines at 590 nm vary from 0.85 to 1.76 nm

5. The explosion products of porous-silicon-based composite. The Scanning Electron Microscopy (SEM) observations of the explosion products' surface were performed using a raster electron microscope JSM-7001F (JEOL, Japan) in secondary electron mode with an acceleration voltage of 10 kV (Fig. 3a) or 5 kV (Fig. 3b, c). The explosion products are a nanostructured material with the predominant content of silicon and oxygen. This material has been formed on the surface of the D16 duralumin plate in the explosive reaction of porous-silicon-based composite with calcium perchlorate as an oxidizer. The distance between the target with a sample and the duralumin plate was approximately equal to 5 cm.