Supplementary material to:

Blacklight sintering of ceramics

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Supplementary 1: Video of the full sintering process using a 450 nm laser

The video features the experimental setup with ceramic wool as insulation and illumination from above. The illuminated area is marked with a blue LED for one second before the laser is turned on because the brightness of the laser is too extreme to identify the illuminated area during the process. After a ten second illumination and laser shutdown, the LED mode is shown again for one second. After that, the cooling of the sample is visible by change of its glowing color.

Supplementary 2: Self-stabilization of temperature

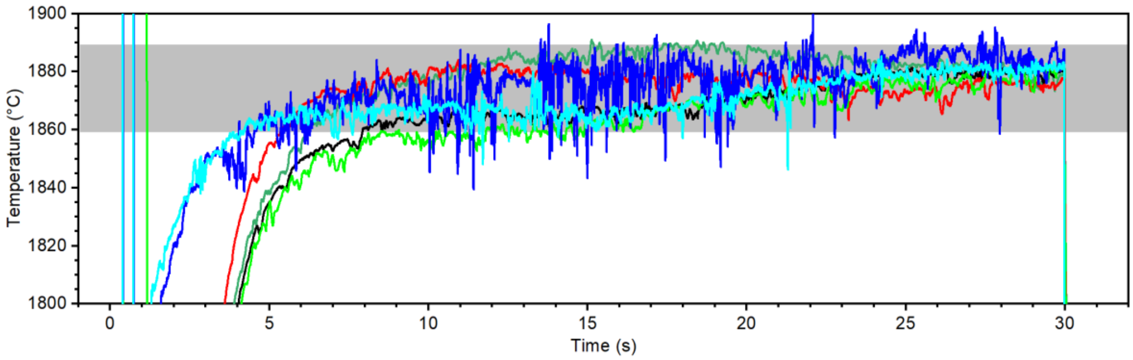

Fig. S1: Self-stabilization of temperature. Six recorded temperature curves from identical sintering experiments of $SrTiO_3$ with 170 Wcm^{-2} of 450 nm laser light on expandable graphite. The light intensity rose from 0 % to 100 % within ≈1 ms and held for 30 seconds while the temperature was recorded with a pyrometer. An interval of ±15 K is highlighted in grey.

Supplementary 3: Challenges in blacklight sintering

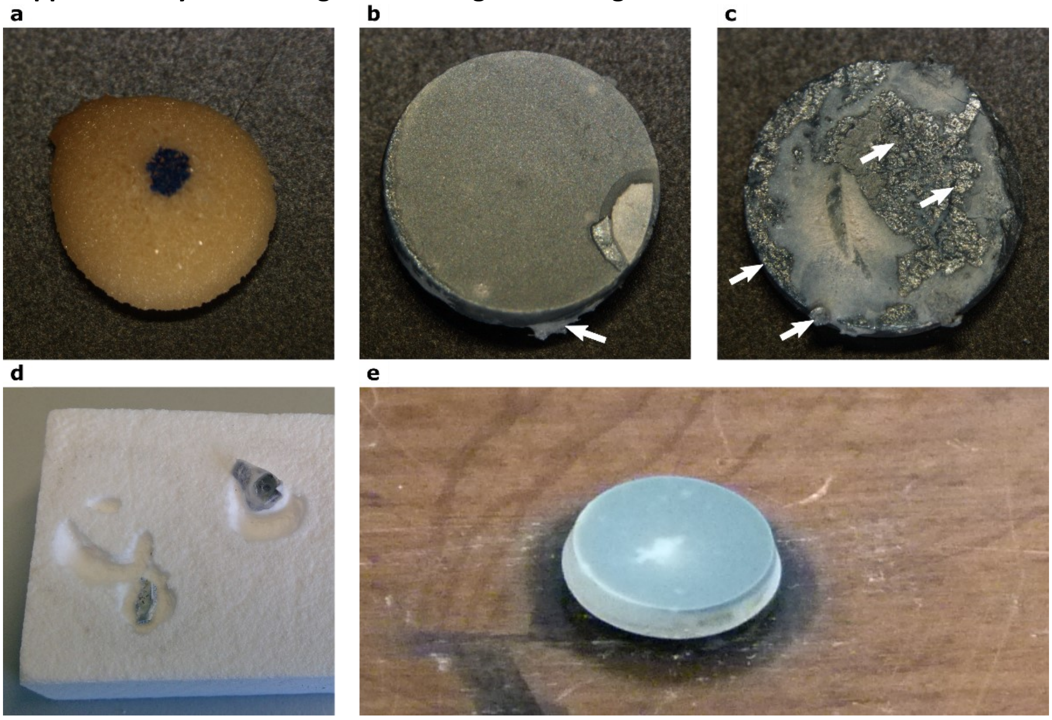

Fig. S2. Challenges in blacklight sintering. (a) $Li_{6.4}La_3Zr_{1.4}Ta_{0.6}O_{12}$ sample used in Fig. 2b which melted after the temperature surge. (b and c) TiO_2 sintered on Al_2O_3/SiO_2 wool with spots where the wool reacted with the sample marked with white arrows. (b) Illuminated side. (c) bottom side. (d) Porous block of Al_2O_3/SiO_2 revealing multiple sites where a sample has reacted with the block. (e) Photograph of a TiO_2 sample illuminated with laser light with 200 Wcm^{-2} for 10 seconds on top of a copper support featuring a surface layer which turned grey and is sintered while the volume closer to the copper support below experienced much less shrinkage.

Supplementary 4: Thermally etched cross section of TiO_2 samples equivalent to Fig. 1k+l

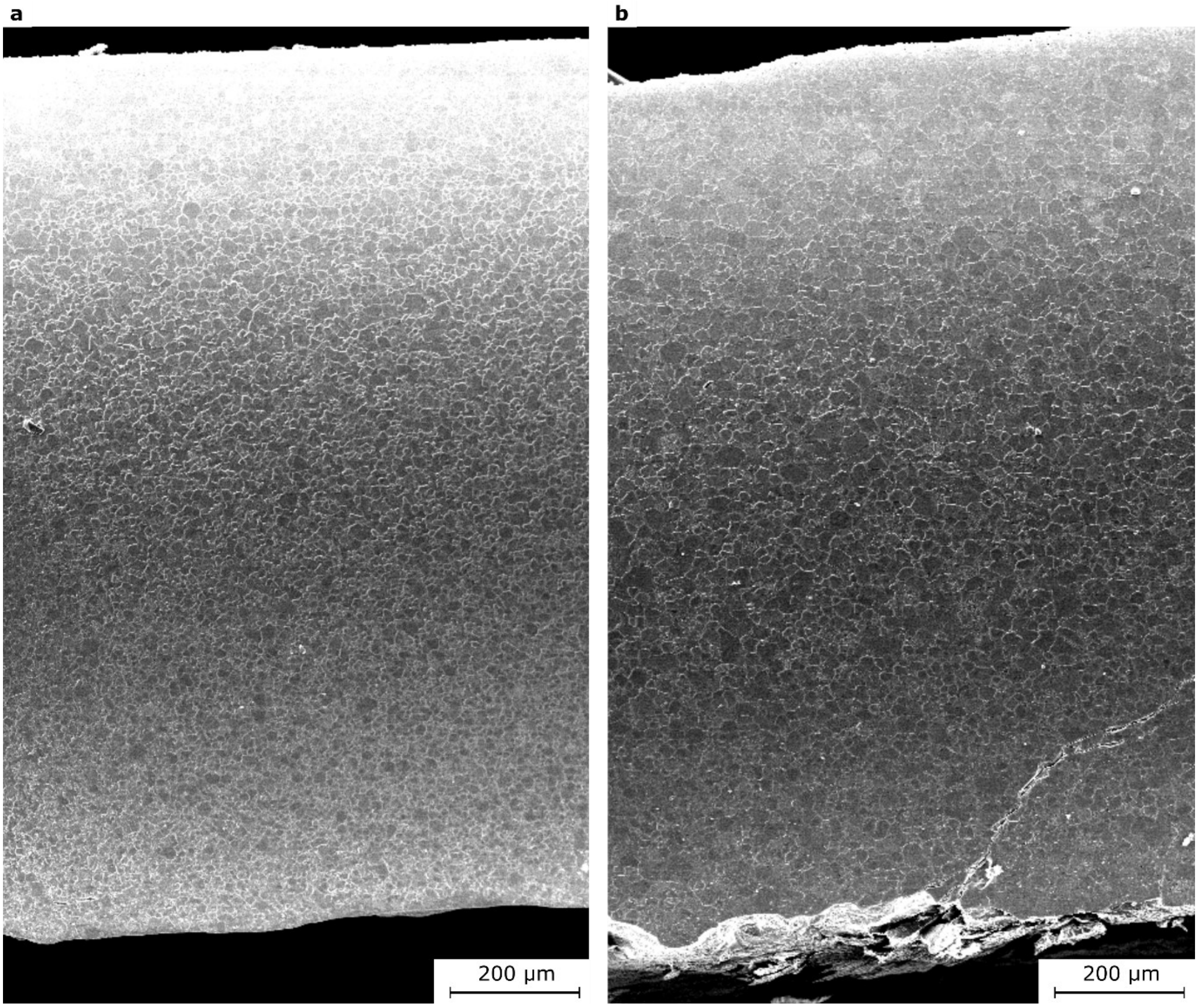

Fig. S3. Thermally etched cross section of TiO_2 samples equivalent to Fig. 1k+l. (a) Sintered with multi-pulse Xe-flash lamp. (b) Sintered with 450 nm laser.

Supplementary 5: Video of FEM model – ceramic wool

FEM model illustrating the temperature evolution in sample and insulation in real time. The temperature gradient within the sample is comparatively low as compared to the gradient in the insulation while the sample temperature largely exceeds the temperature of the bulk of the insulation. Scale in Kelvin.

Supplementary 6: Video of FEM model – copper

FEM model illustrating the temperature evolution in sample and copper support in real time. A large temperature gradient can be observed in the sample but not in the copper. Simultaneously, the sample reaches only much lower temperatures compared to movie S6 while the copper heats up substantially. Scale in Kelvin. Note the difference in color scale between the two videos.

Supplementary 7: Evidence for texture in the surface layer sintered with a single flash from a Xe-flash lamp

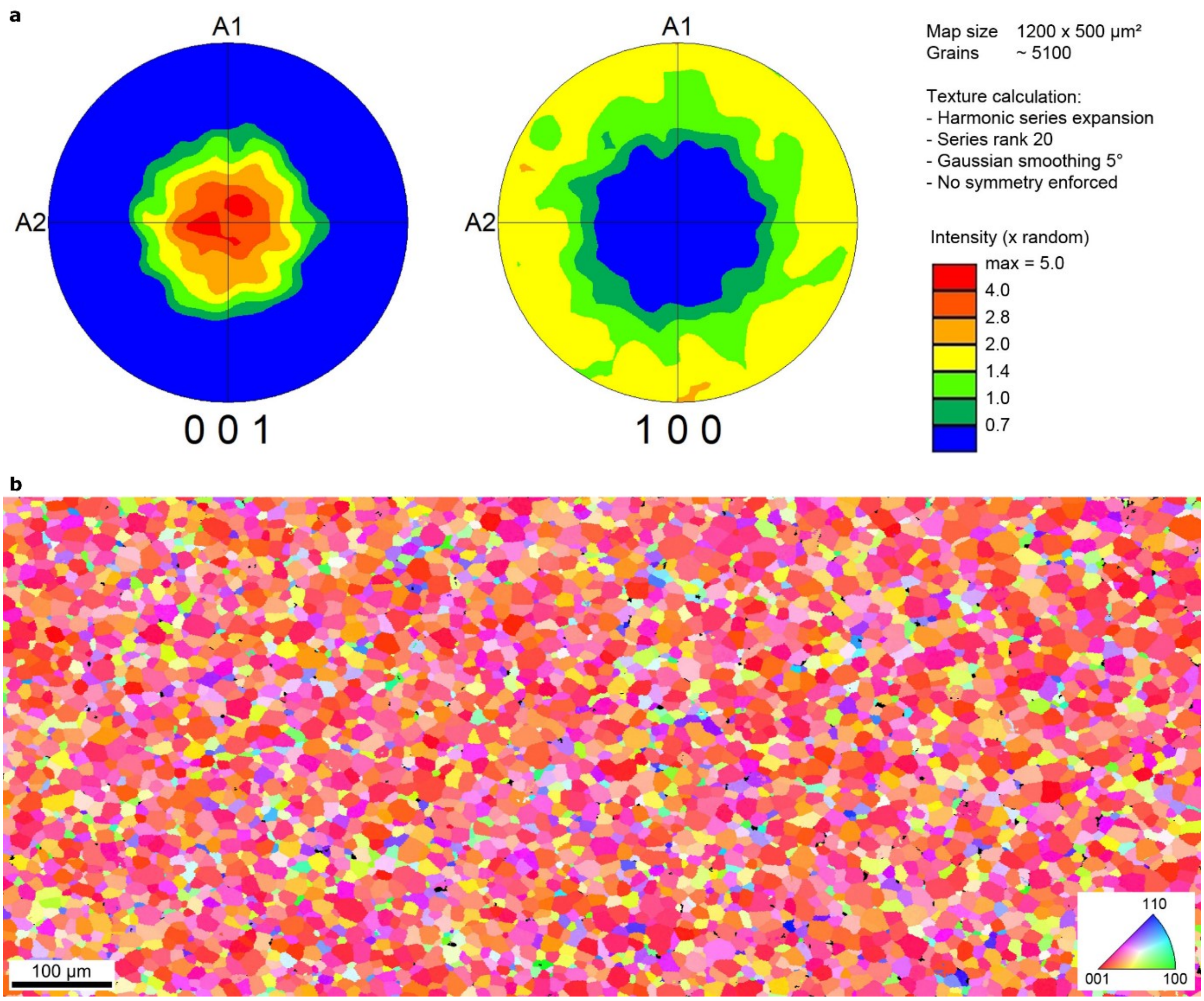

Fig. S4. Evidence for texture in the surface layer sintered with a single flash from a Xe-flash lamp. (a) Pole figure plot visualizing the crystallographic texture. (b) Inverse pole figure map of the underlying EBSD scan of a TiO_2 sample. The texture analysis reveals a pronounced crystallographic texture with <001> || surface normal.

Supplementary 8: Cross-validation of results of 450 nm laser and multi-pulse Xe-flash lamp

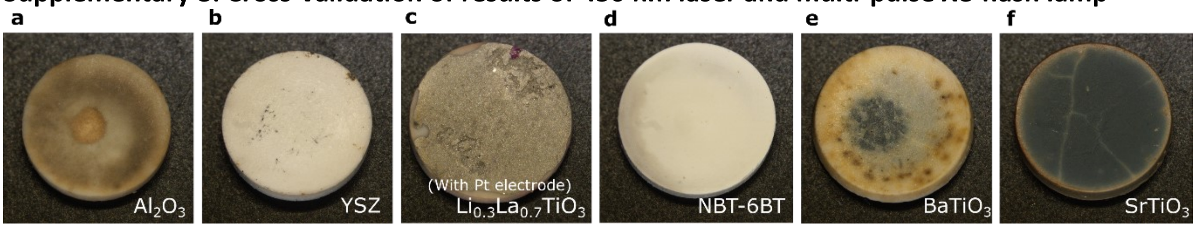

Fig. S5. Cross-validation of results of 450 nm laser and multi-pulse Xe-flash lamp. (a-f) Photographs of samples fabricated with 450 nm laser with parameters specified in methods section as counterpart to samples displayed in Fig. 4h-m.

Supplementary 9: Microstructure images of freshly polished samples prepared with 450 nm laser light

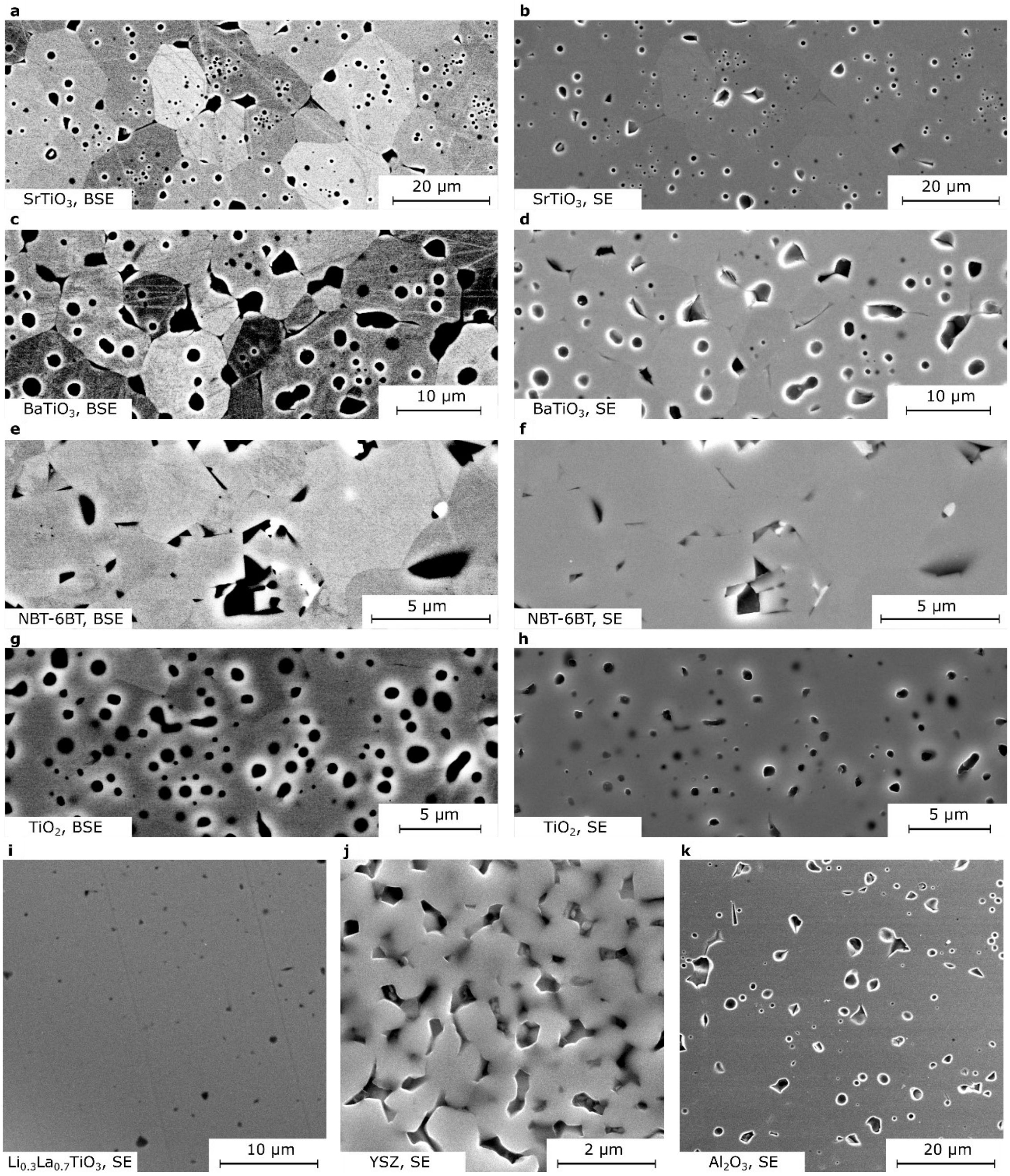

Fig. S6. Microstructure images of freshly polished samples prepared with 450 nm laser light. All processing parameters can be found in the methods section. If images with both backscattered electron contrast and secondary electron contrast are provided, the identical region is displayed. (a and b) $SrTiO_3$. (c and d) $BaTiO_3$. (e and f) NBT-6BT. (g and h) TiO_2 equivalent to Fig. 1k. (i) $Li_{0.3}La_{0.7}TiO_3$. (j) Yttrium stabilized zirconia. (k) Al_2O_3.

Supplementary 10: Microstructure images of freshly polished samples prepared with a multi-pulse Xe-flash lamp

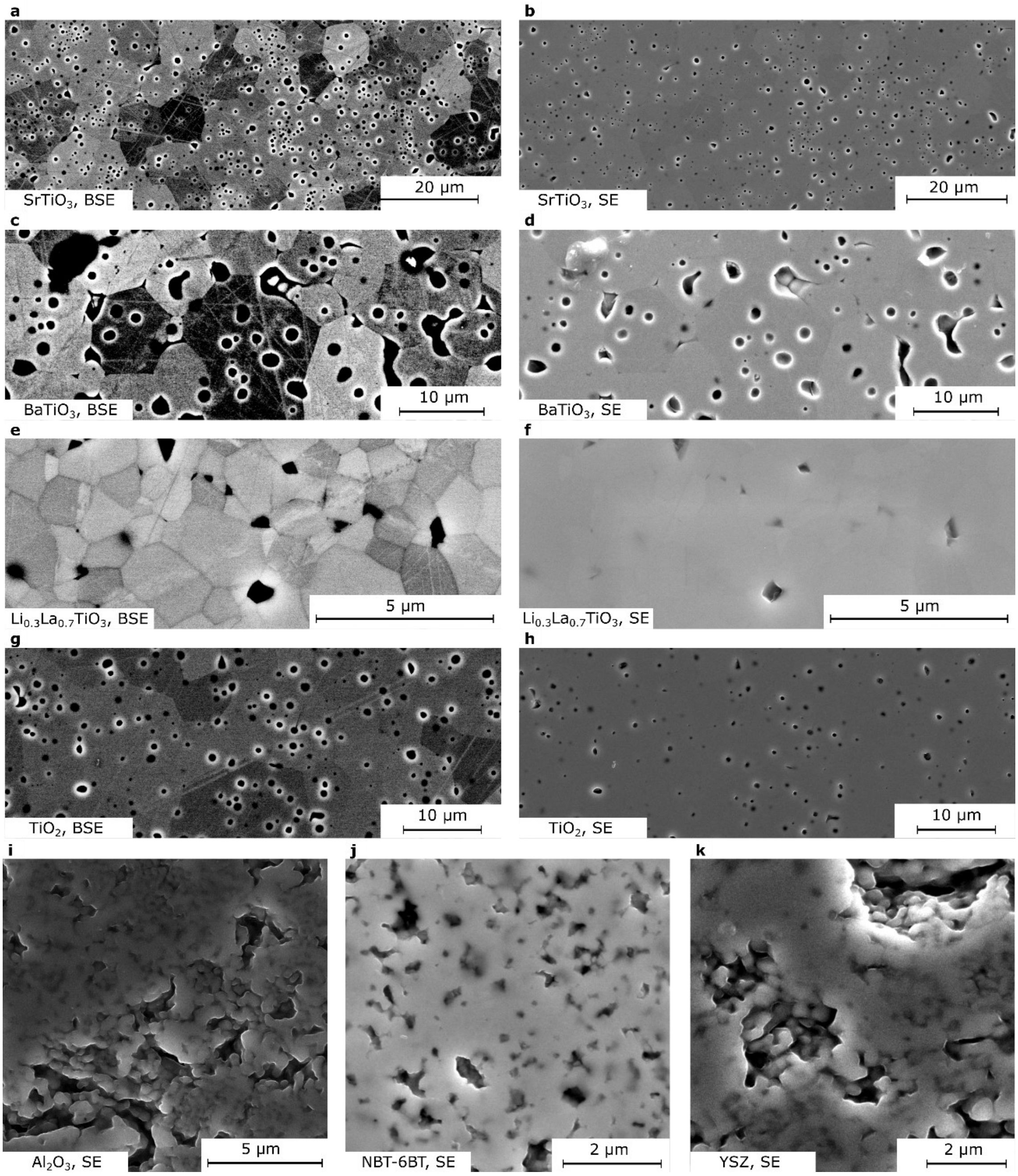

Fig. S7. Microstructure images of freshly polished samples prepared with a multi-pulse Xe-flash lamp. All processing parameters can be found in the methods section. If images with both backscattered electron contrast and secondary electron contrast are depicted, the identical region is displayed. (a and b) $SrTiO_3$. (c and d) $BaTiO_3$. (e and f) $Li_{0.3}La_{0.7}TiO_3$. (g and h) TiO_2 equivalent to Fig. 1j. (i) Al_2O_3. (j) NBT-6BT. (k) Yttrium stabilized zirconia.