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Supplemental information

Ultrafast high-temperature sintering to avoid metal loss toward high-performance and scalable cermets

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Supplemental Information

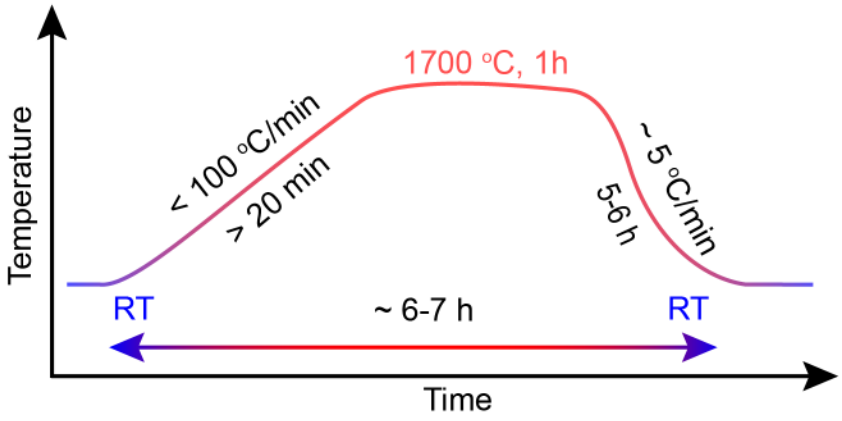

Figure S1. The temperature profile during the conventional furnace sintering process.

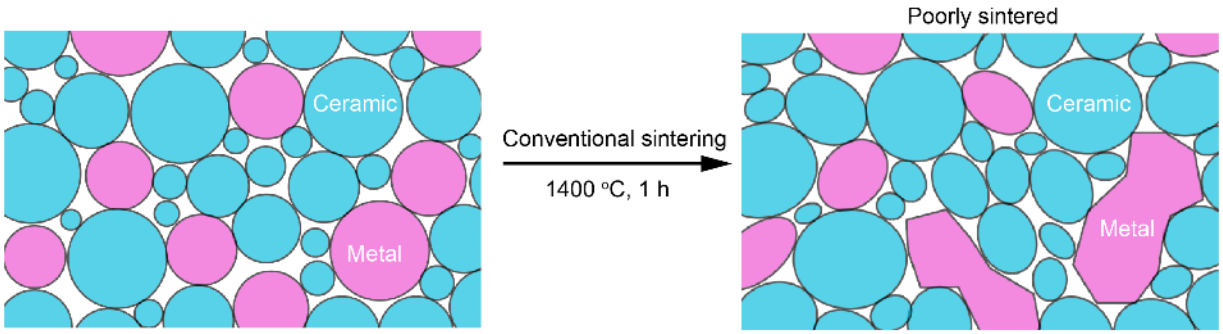

Figure S2. Schematic of conventional furnace sintering for cermets at a low temperature. Metal phase can be densified but the ceramic phase cannot.

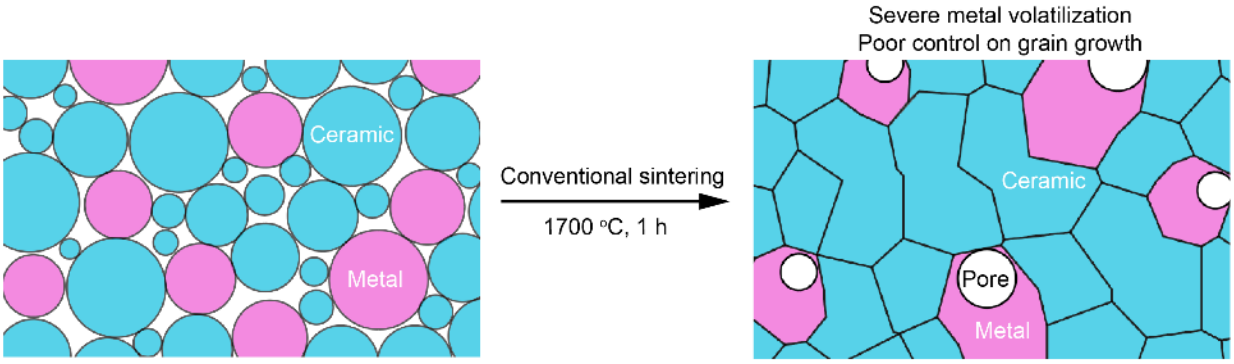

Figure S3. Schematic of conventional furnace sintering for cermets at a high temperature. Severe metal volatilization is normal due to the long sintering duration, which leads to porous microstructure.

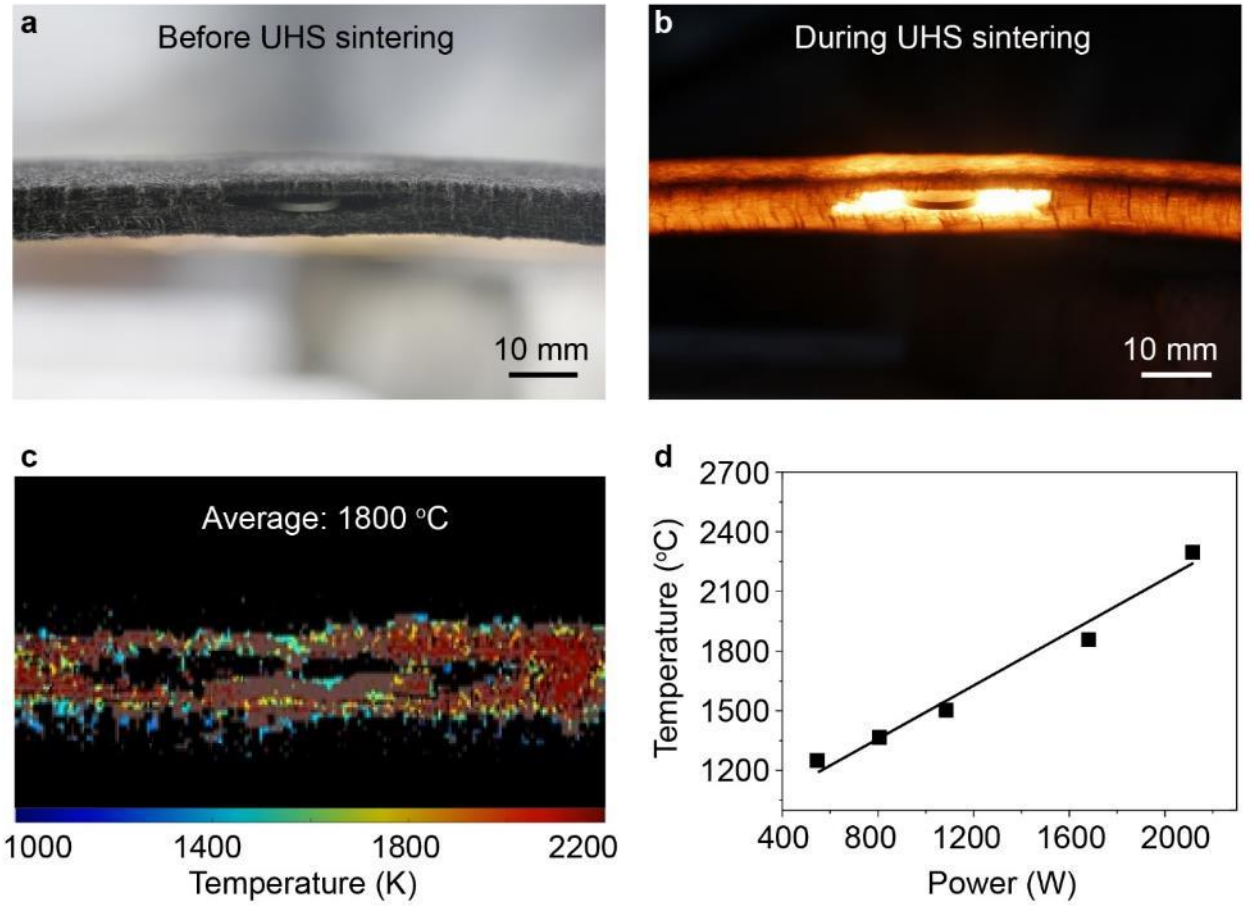

Figure S4. (a) The green pellet sandwiched between two Joule-heated carbon felt strips before sintering. (b) Pellet sample sandwiched between two Joule-heated carbon felt strips during sintering. (c) The corresponding temperature distribution measured by a thermal sensing camera. (d) The temperature-power relationship (heater size: 12.5 cm × 1.3 cm × 5 mm).

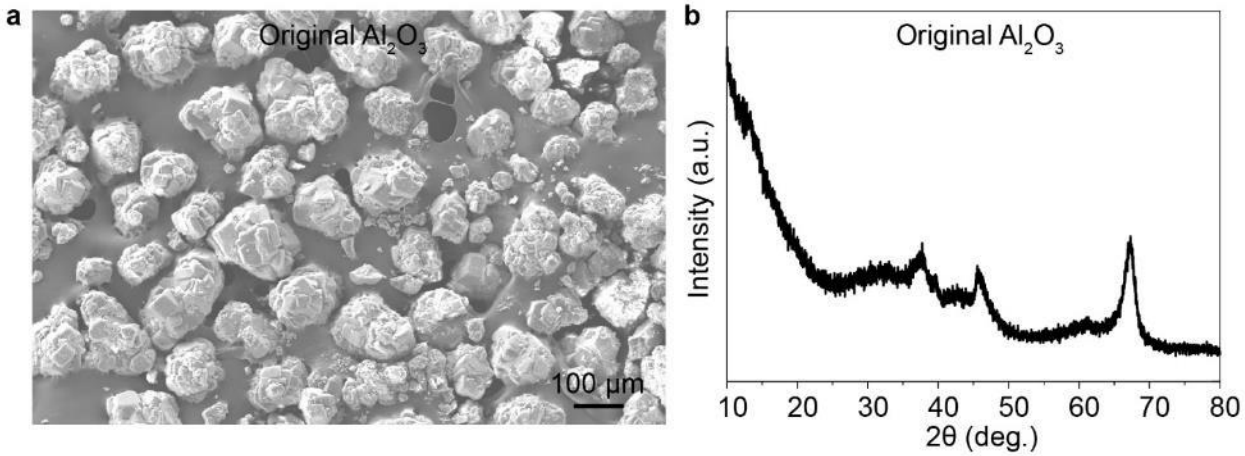

Figure S5. SEM image (a) and XRD pattern (b) of the original Al_2O_3 precursor powder used in the cermet.

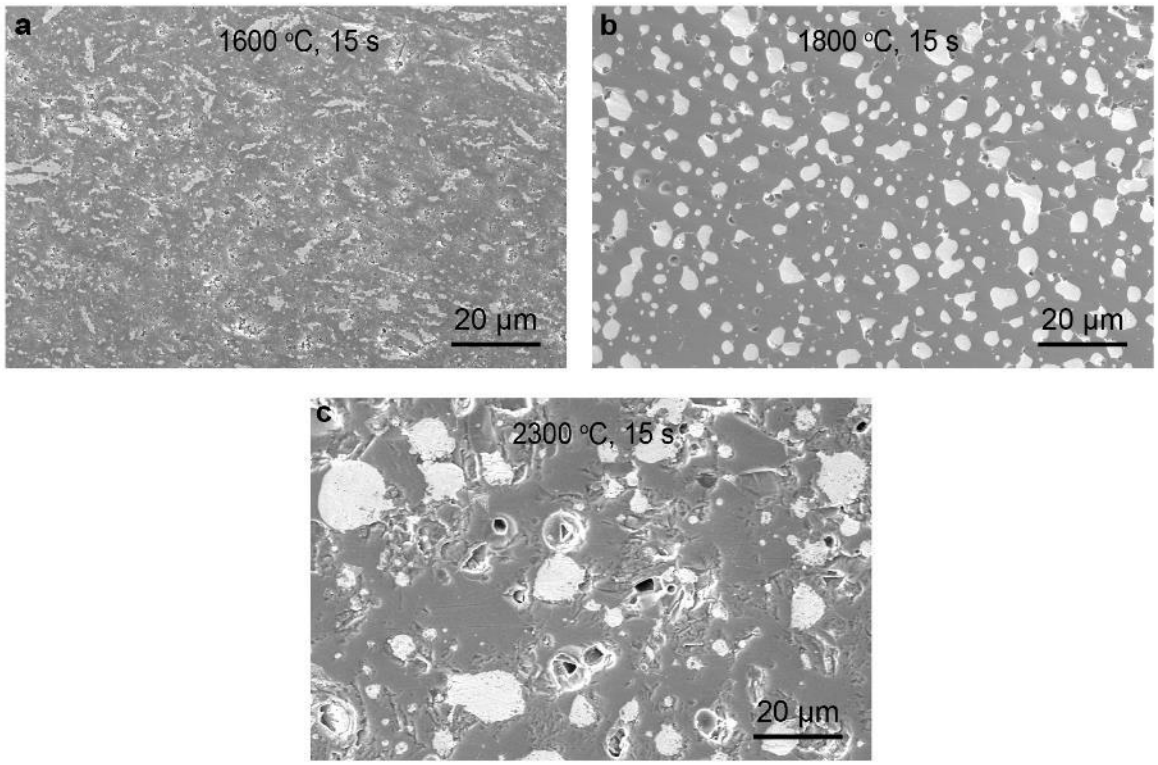

Figure S6. Low magnification SEM images of the cermet composed of a Ni-based superalloy and Al_2O_3 sintered at 1600 ℃ (a), 1800 ℃ (b) and 2300 ℃ (c) for 15 s.

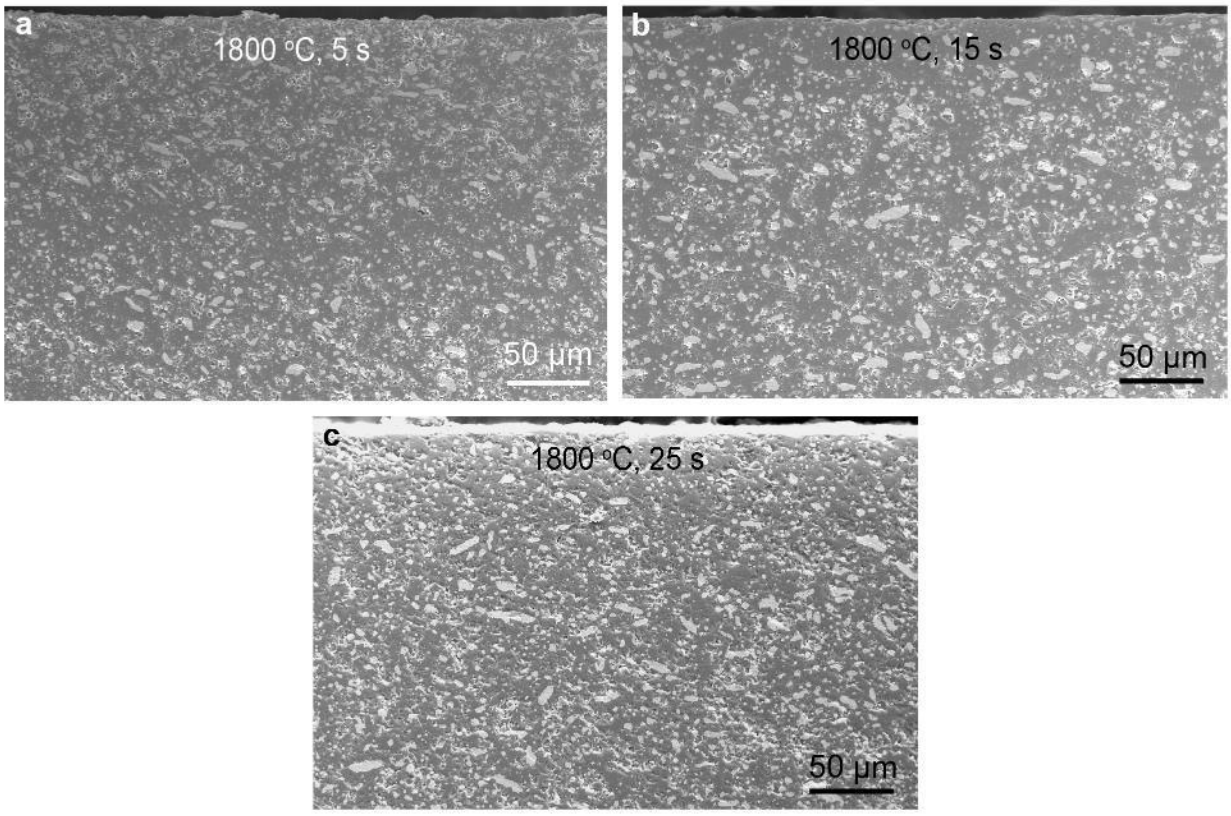

Figure S7. Low magnification SEM images of the cermet composed of a Ni-based superalloy and Al_2O_3 sintered at 1800 ℃ for 5 s (a), 15 s (b) and 25 s (c).

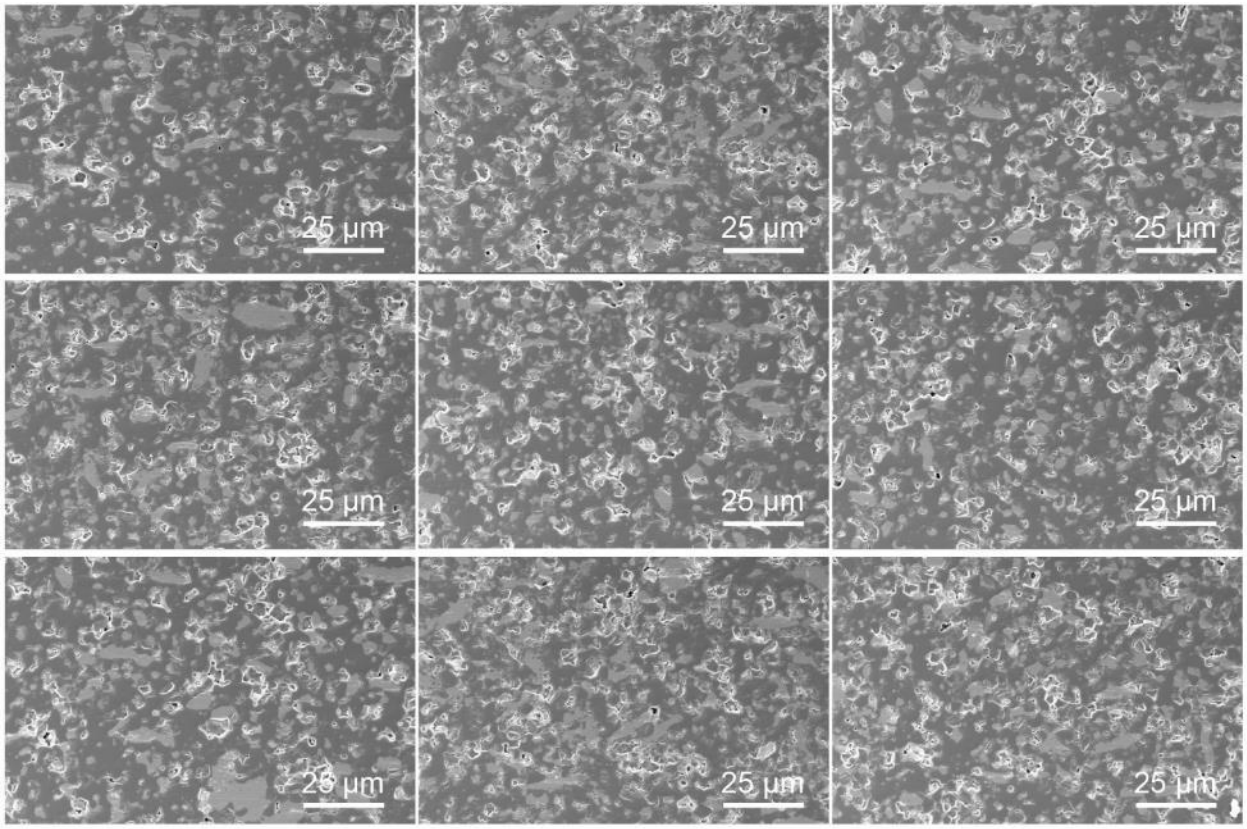

Figure S8. SEM images for different positions of the UHS sintered Ni-based superalloy and Al_2O_3 cermet at 1800 ℃ for 15 s.

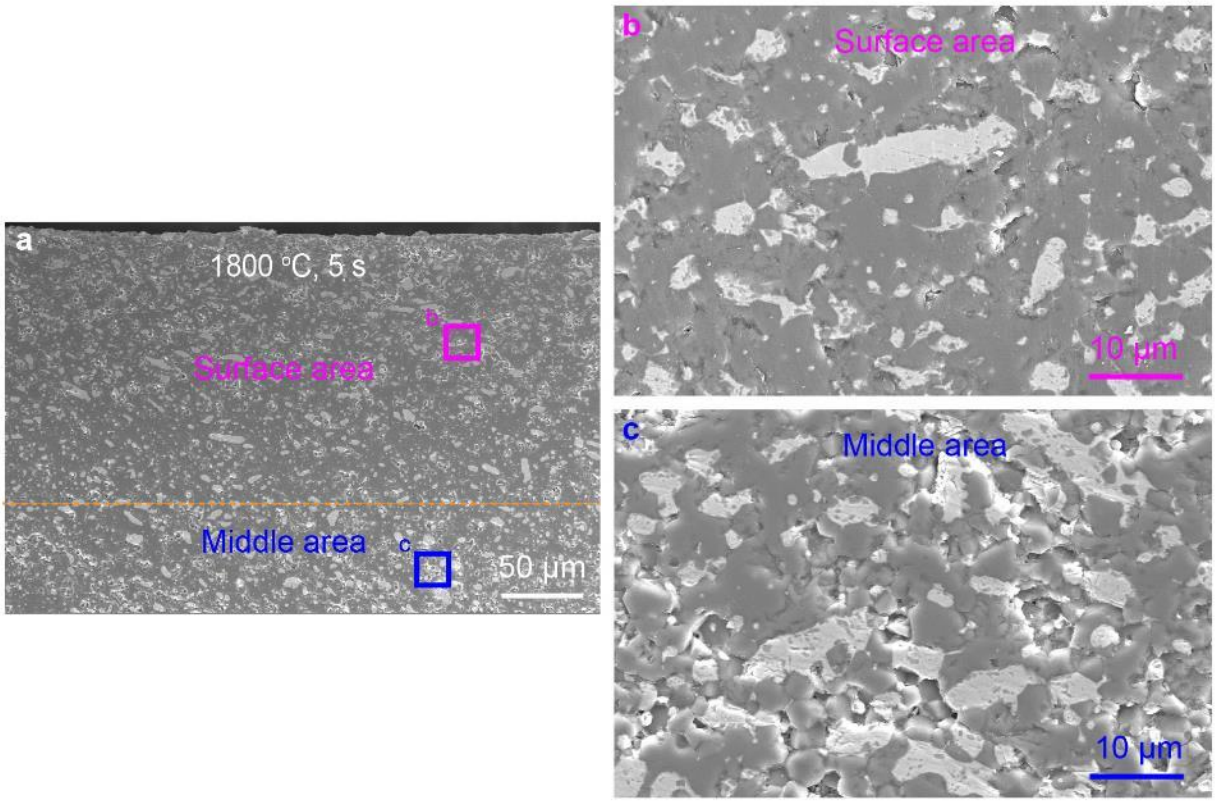

Figure S9. SEM images of the cermet composed of a Ni-based superalloy and Al_2O_3 sintered at 1800 ℃ for 5 s.

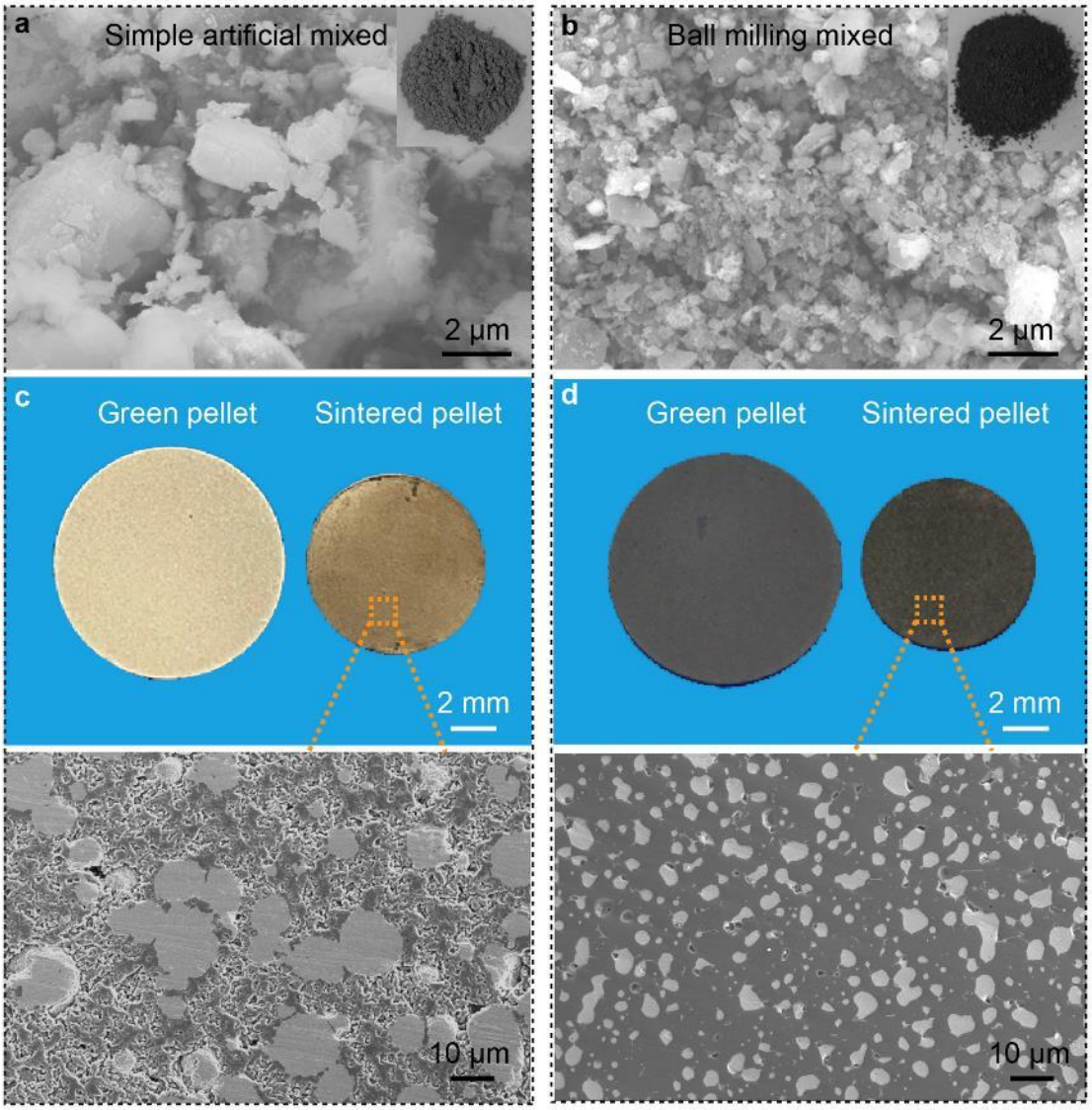

Figure S10. Effects of the state of mixing (Ni-based superalloy and Al_2O_3 powders with a volume ration is 1:4) on sintering. SEM image of the mixture by simple grinding (a) and by 12 h ball milling (b). Insets are the corresponding pictures of the mixed powder. (c) Pictures of the green and sintered pellet (1800 ℃, 15 s) made from grinded precursor powders and the SEM image of the sintered pellet. (d) Pictures of the green and sintered pellet (1800 ℃, 15 s) made from ball milled precursor powders and the SEM image of the sintered pellet.

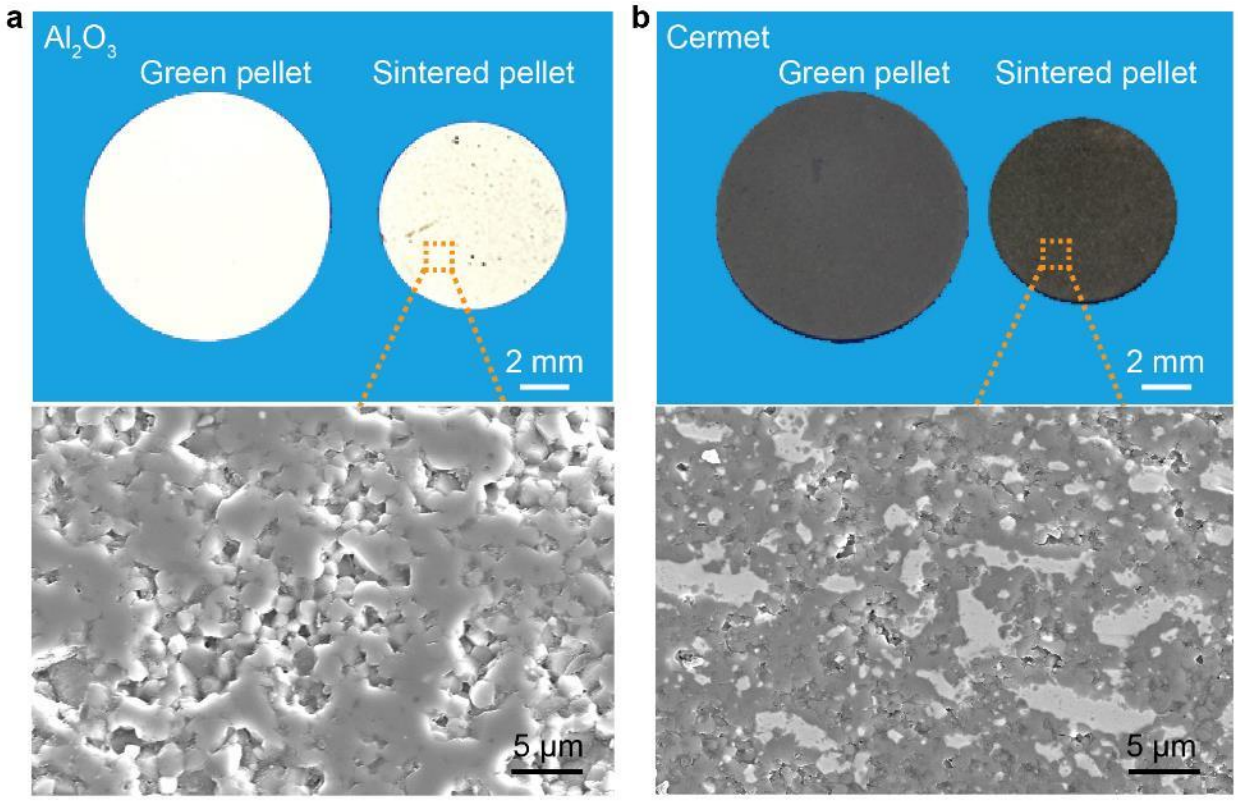

Figure S11. Pictures and SEM images of pure Al_2O_3 (a) and cermet composed of a Ni-based superalloy and Al_2O_3 (b) sintered in the same batch. The cermet shown in b was not sintered at the most optimal condition, which only serves as an example to show the better densification of the pellet once the metal phase is incorporated.

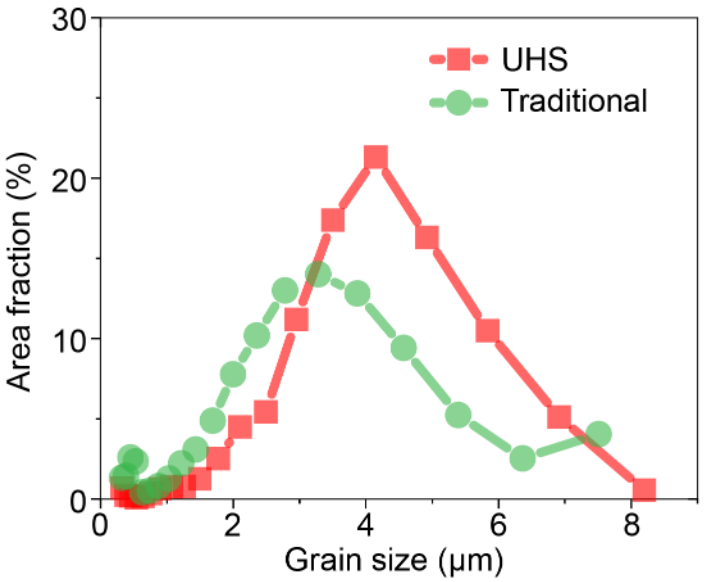

Figure S12. Grain size distribution of cermet composed of a Ni-based superalloy and Al_2O_3 sintered by traditional furnace and our ultrafast sintering method. The analysis is based on the EBSD mapping results.

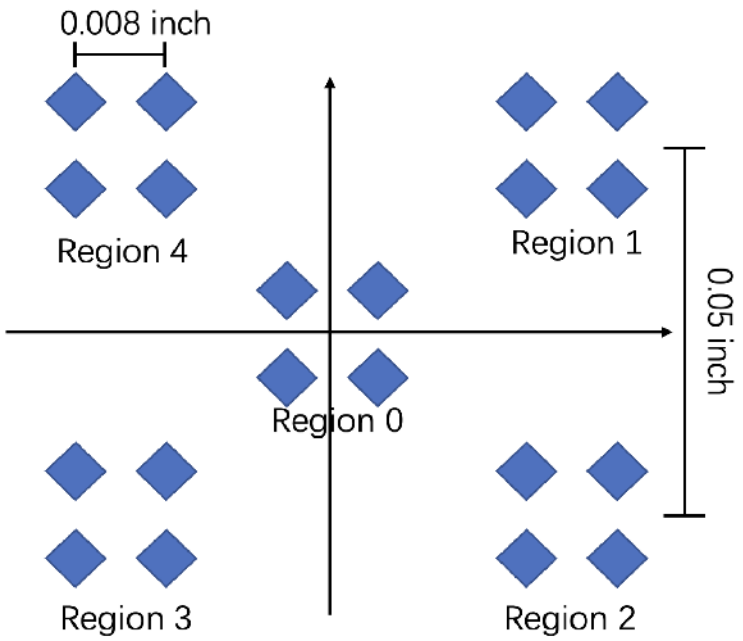

Figure S13. The regional distribution map for Vickers hardness tests on the cermet composed of a Ni-based superalloy and Al_2O_3.

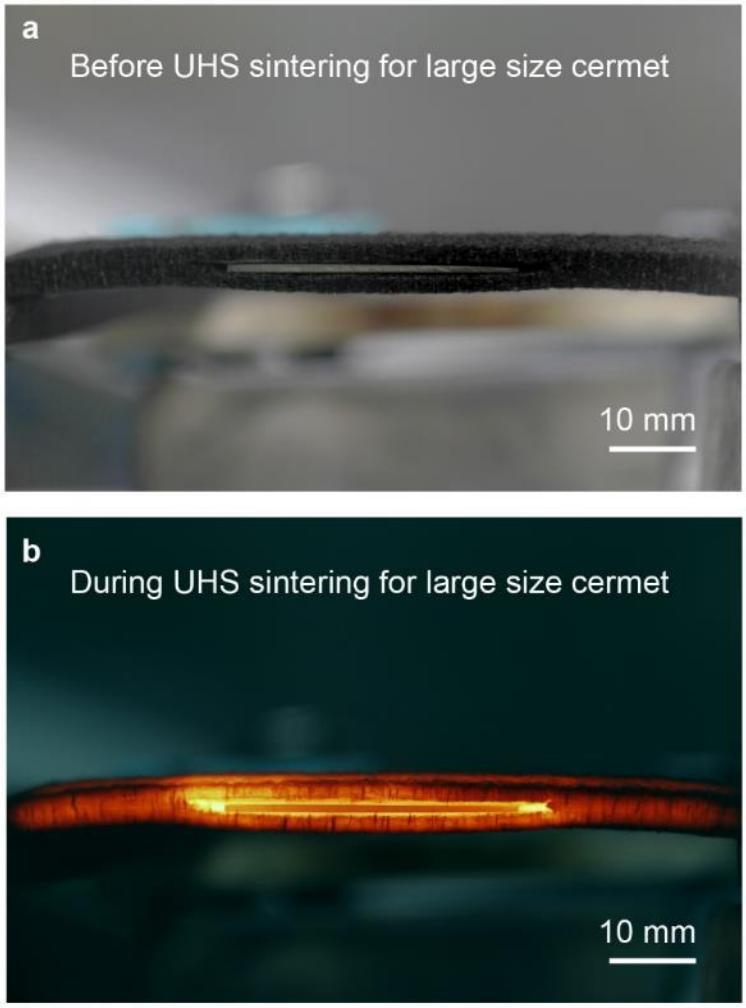

Figure S14. Pictures of a large size Ni-based superalloy and Al_2O_3 cermet sandwiched between two large size Joule-heating carbon felt strips before (a) and during (b) our ultrafast sintering.

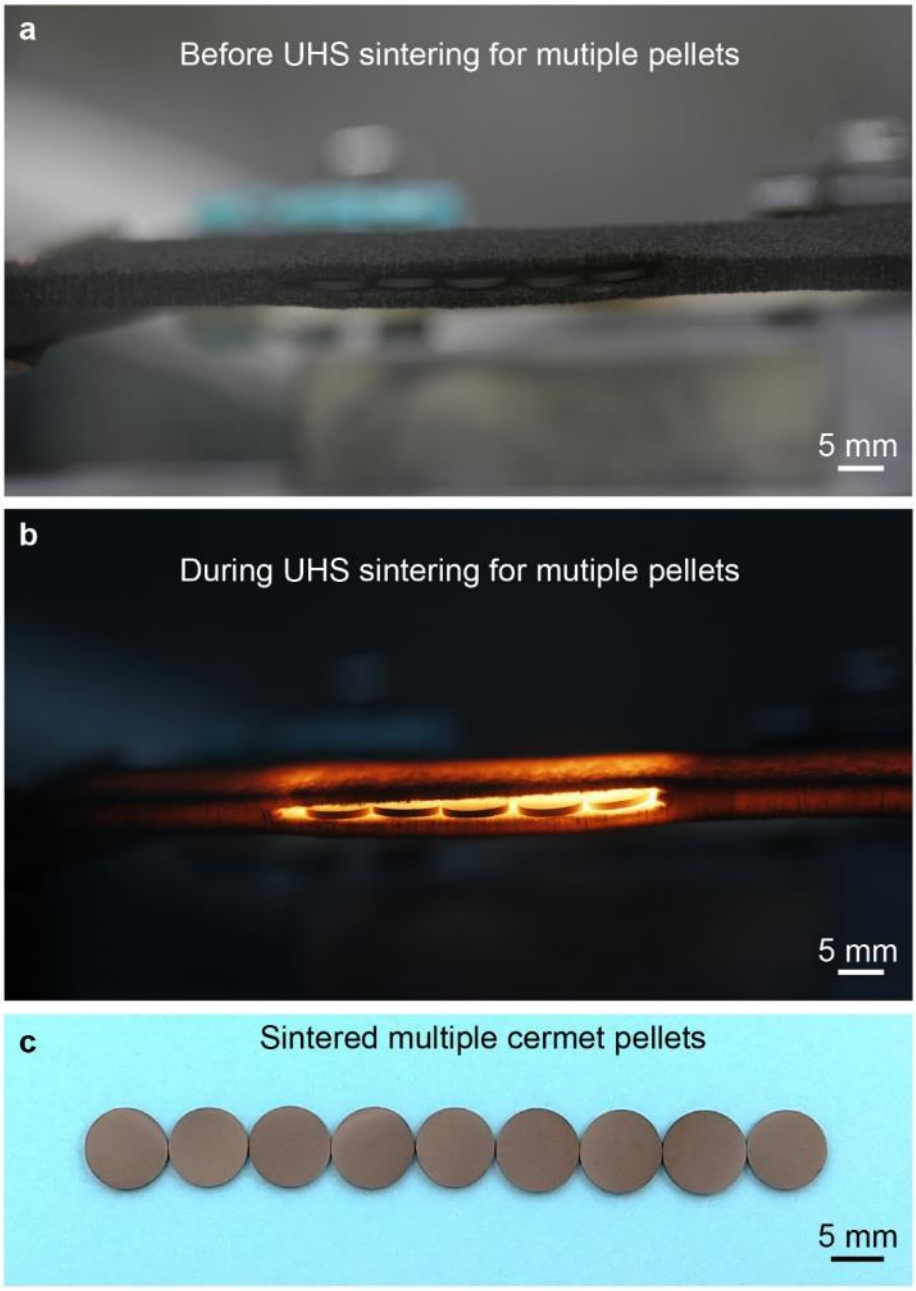

Figure S15. Sintering multiple cermet pellets simultaneously. Multiple green pellets sandwiched between two large size Joule-heating carbon felt strips before (a) and during (b) our ultrafast sintering. (c) Picture of the cermet pellets sintered in one batch.

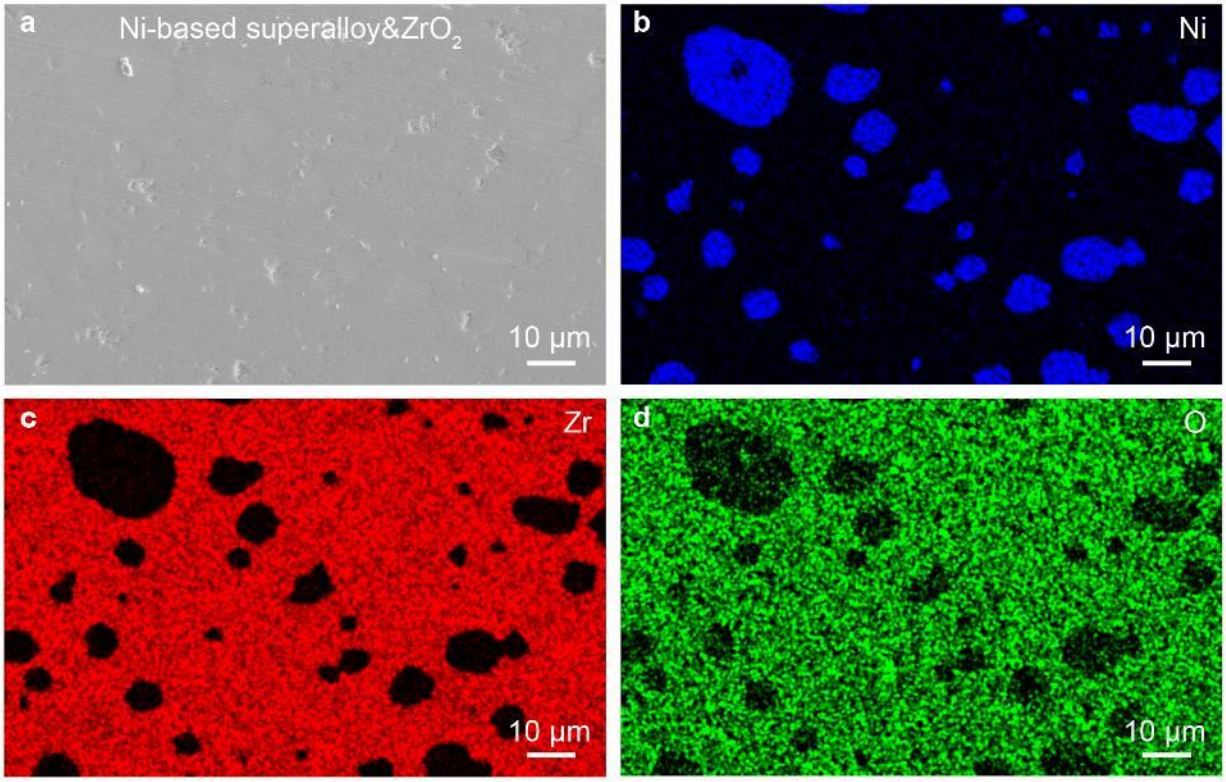

Figure S16. SEM and EDS mapping of the cermet composed of a Ni-based superalloy and ZrO_2 (1:4 in volume) sintered using our ultrafast method.

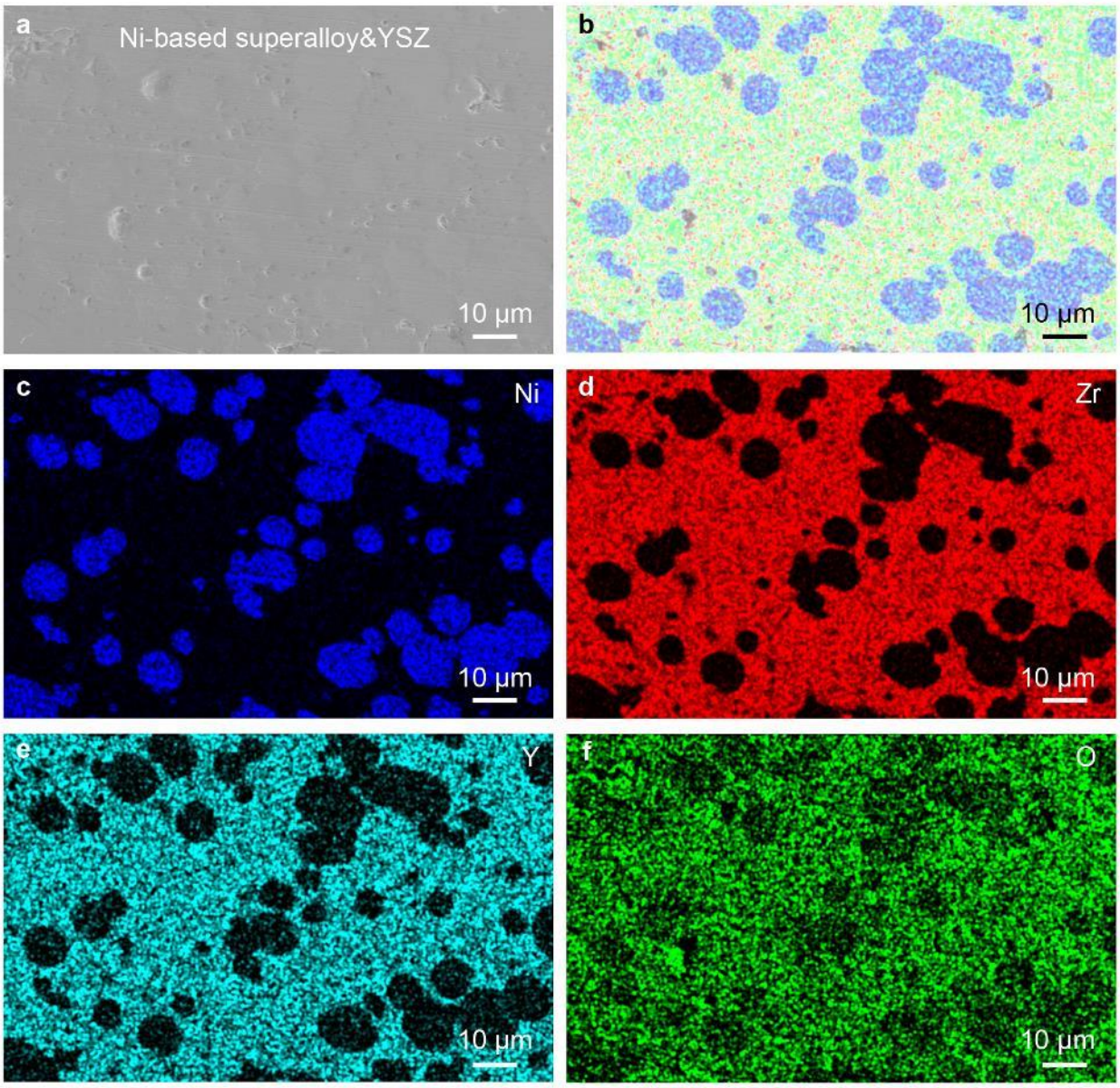

Figure S17. SEM and EDS mapping of the cermet composed of a Ni-based superalloy and YSZ (1:4 in volume) sintered using our ultrafast method.