

## Supplementary information

### Carbonization of transition metals in molten salt

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Fig. S1

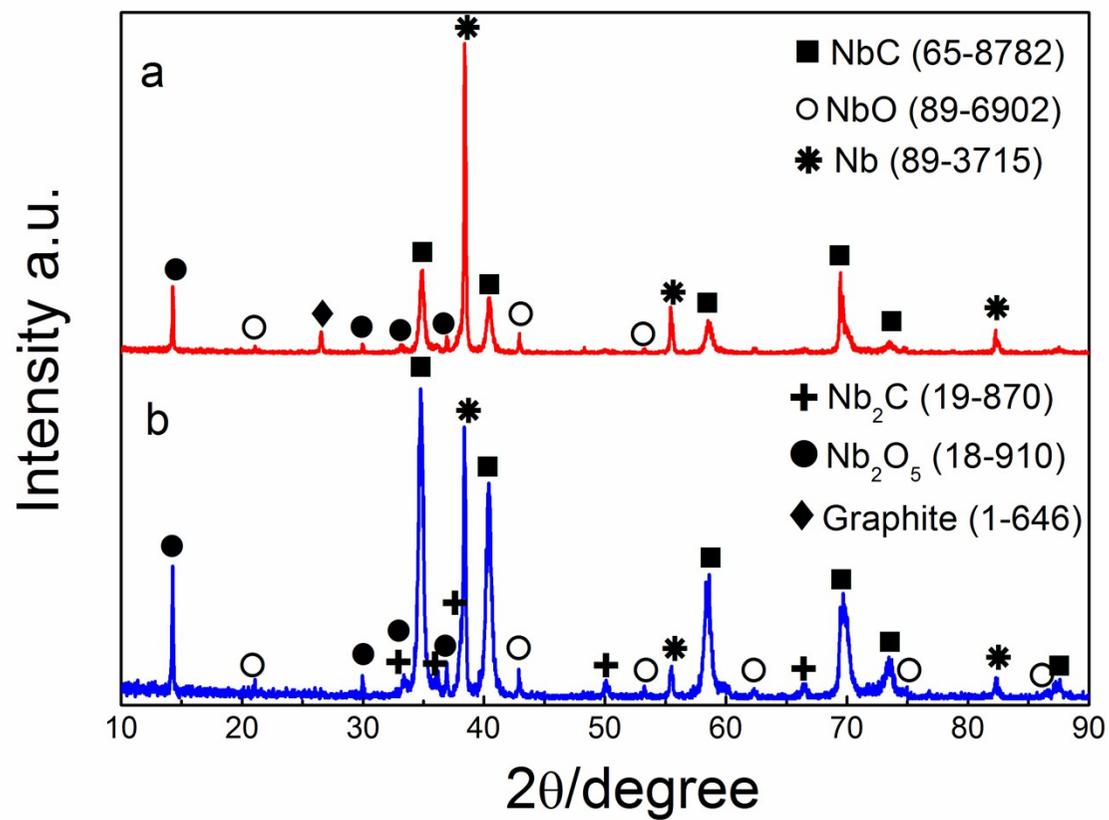


Fig. S1 XRD patterns of the samples prepared from the mixture of (a) Nb and C3; (b) Nb and C4 under 0.5V for 8 h in molten salt.

Fig. S2

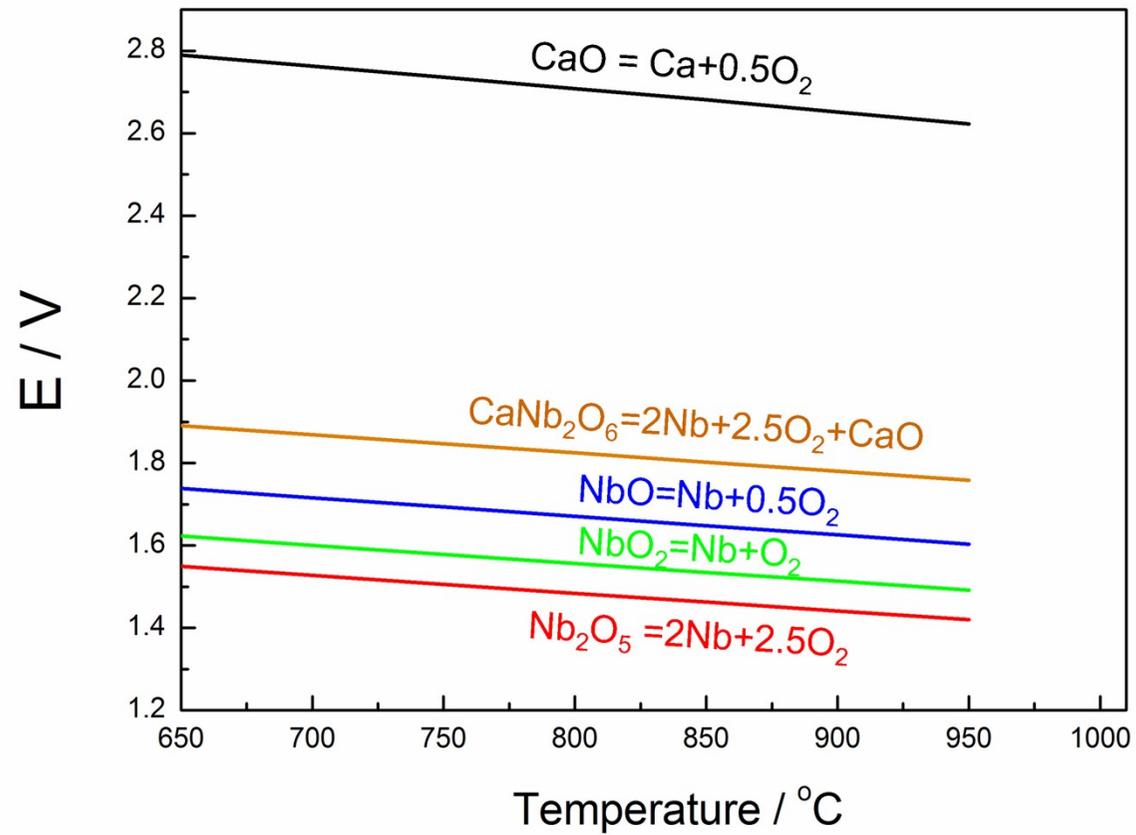
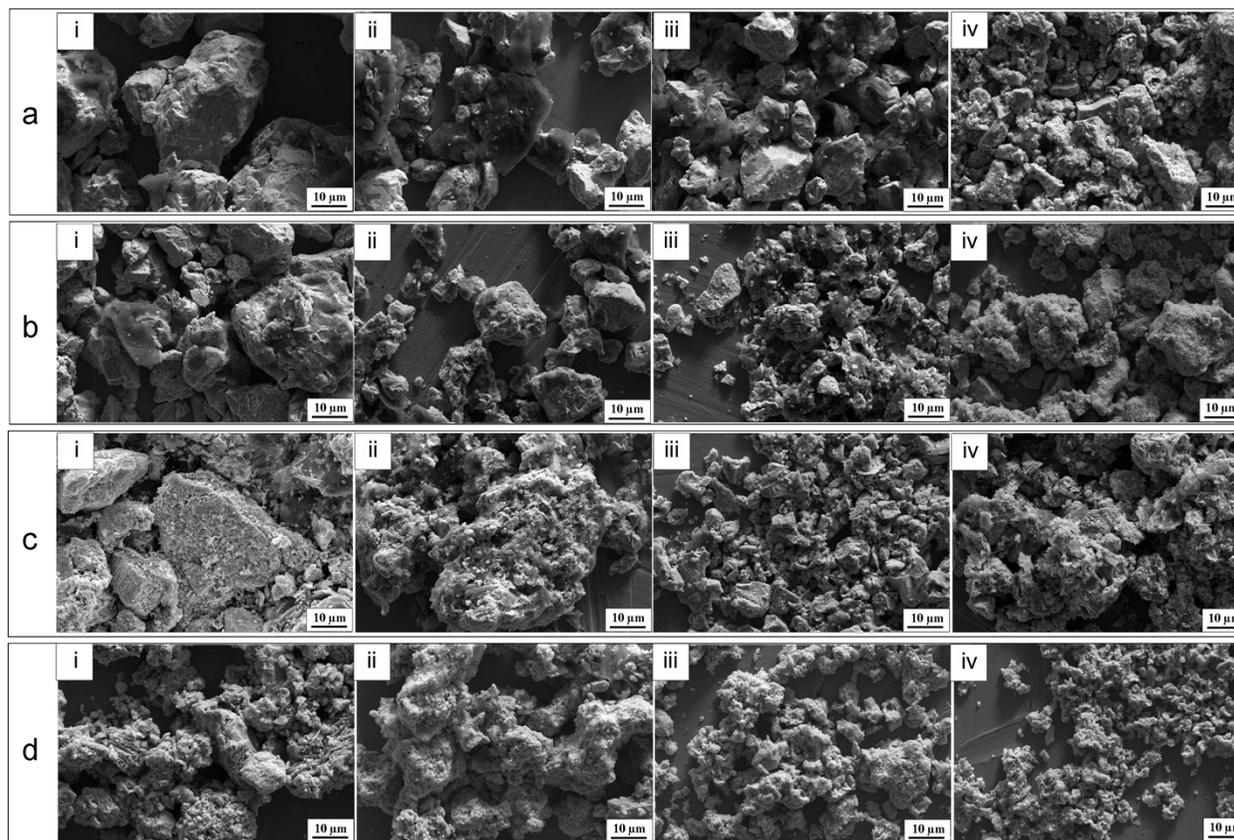


Fig. S2 Theoretical decomposition potentials of typical niobium oxides and calcium niobate possibly present on the surface of Nb particles

**Fig. S3**



**Fig. S3** SEM images (lower magnification) of the samples prepared by the carbonization of niobium for 8 h at 900 °C in (a) Ar atmosphere; (b) molten salt; (c) molten salt with the assistance of an electric field of 2.0 V; (d) molten salt with the electro-deoxidation of Nb<sub>2</sub>O<sub>5</sub> under 3.0 V prior to the carbonization. Carbon powders of (i) C1; (ii) C2 ; (iii) C3 and (iv) C4 were used as the carbon source in all the carbonization processes.

Fig. S4

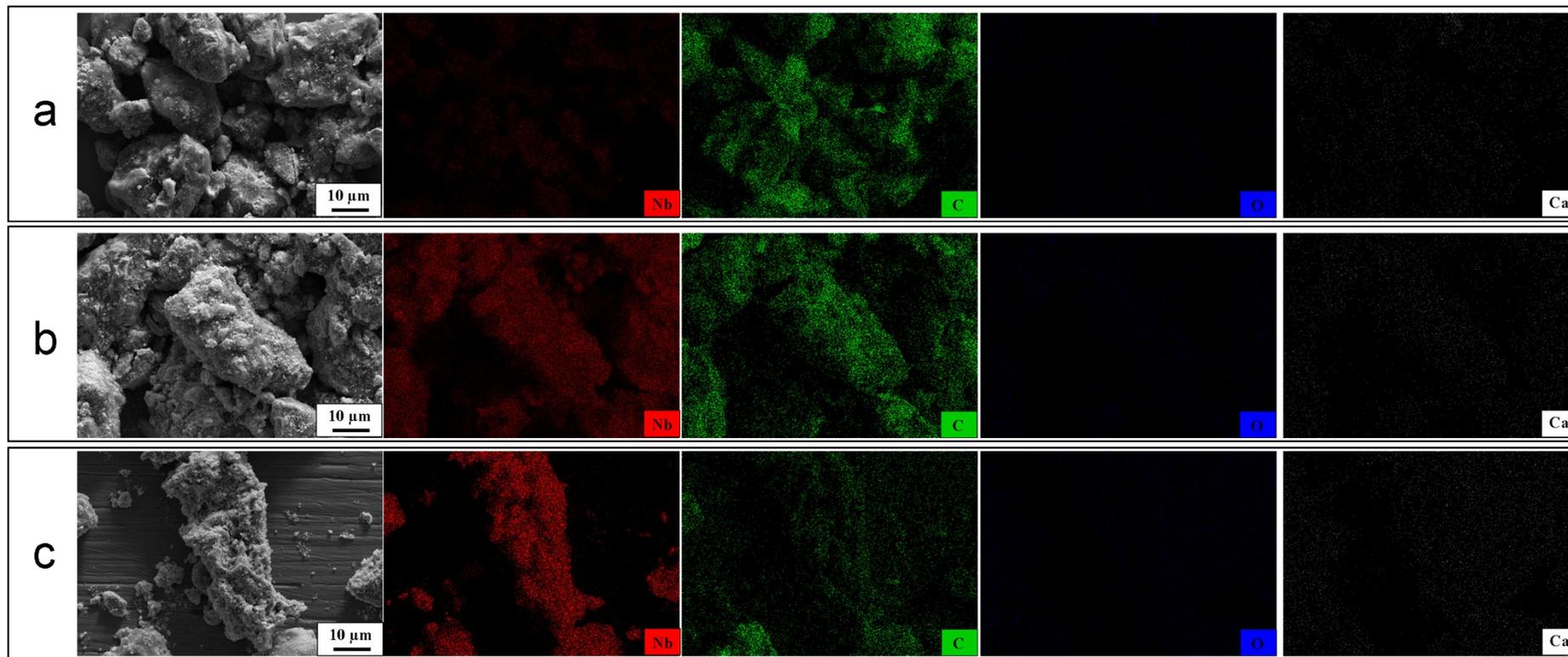
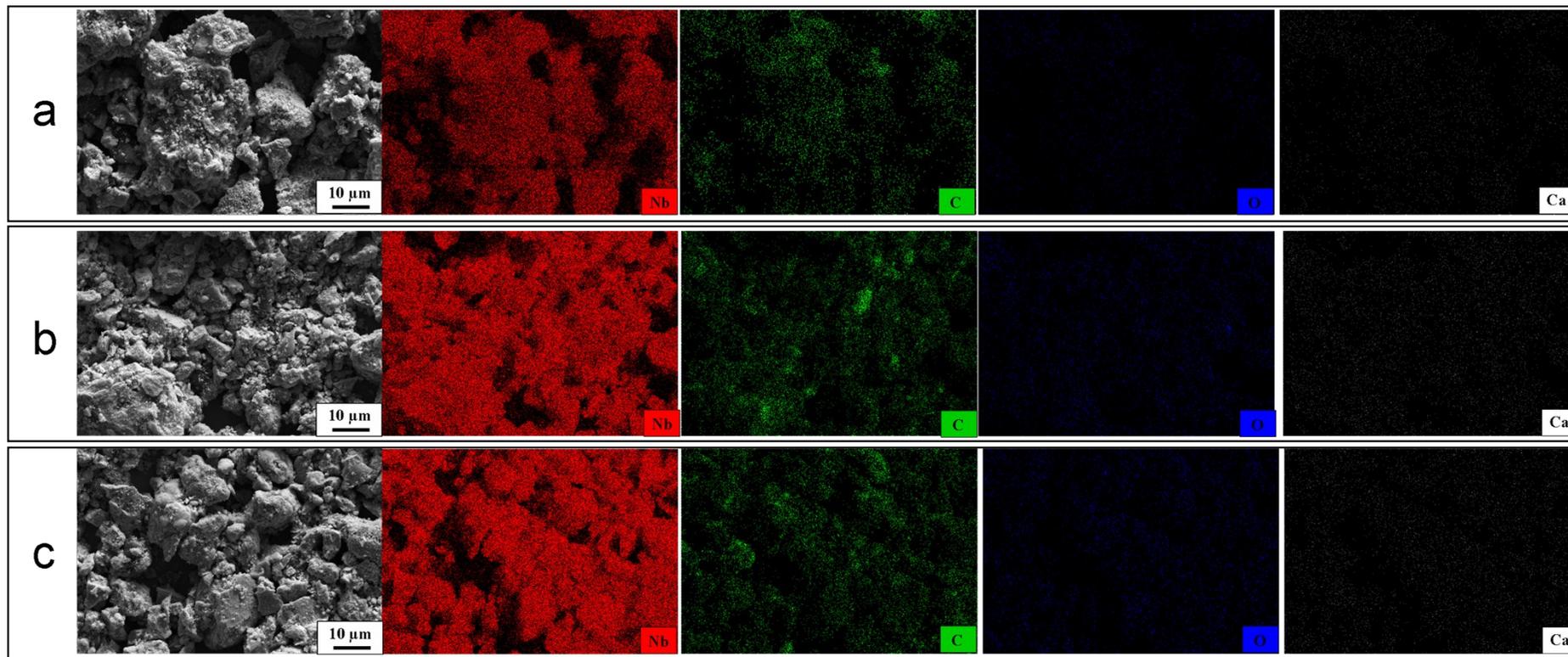


Fig. S4 EDS elemental mapping of the products for (a) 1.5; (b) 3 and (c) 6 h of carbonization in molten salt from the Nb-C4 precursor.

Fig. S5



**Fig. S5** EDS elemental mapping of the products for (a) 1.5; (b) 3 and (c) 6 h of carbonization with the assistance of an electric field of 2.0 V in molten salt from the Nb-C4 precursor.

Fig. S6

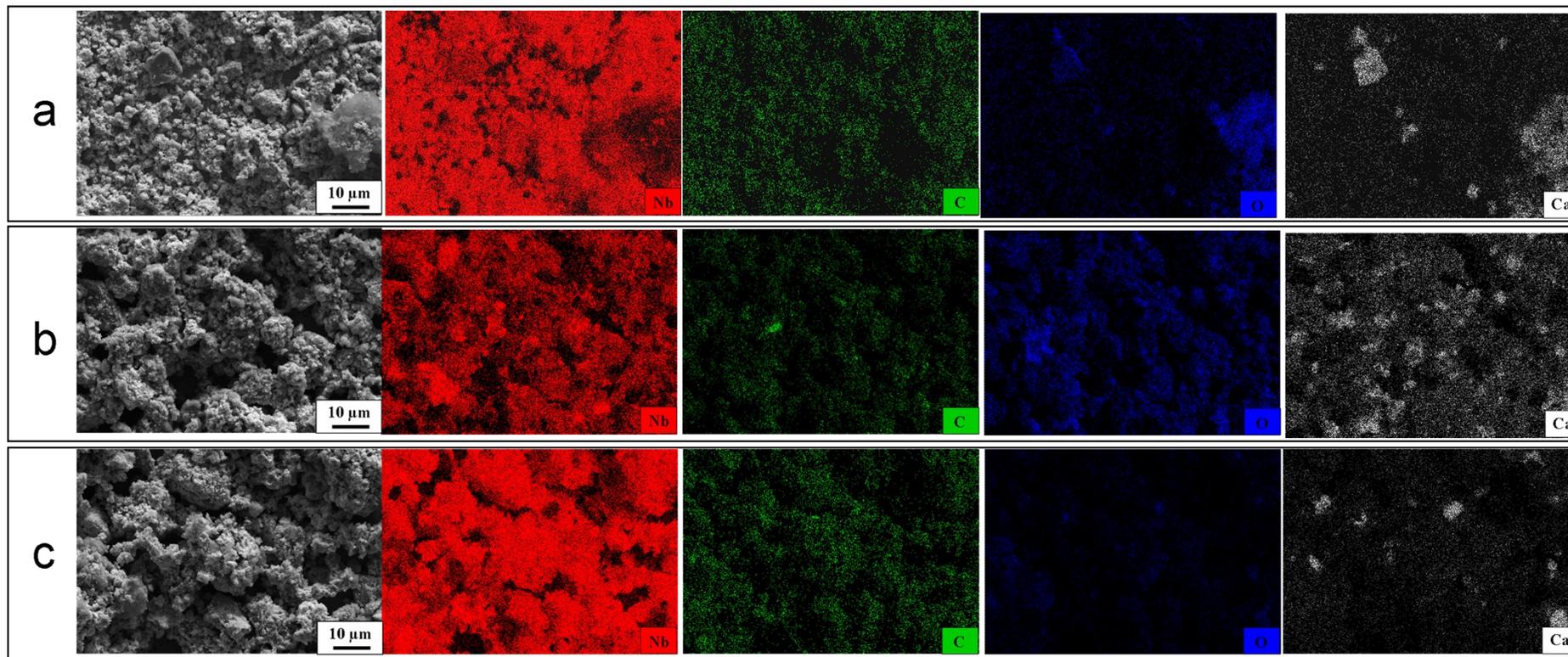


Fig. S6 EDS elemental mapping of the products for (a) 1.5; (b) 3 and (c) 6 h of carbonization in molten salt from the  $\text{Nb}_2\text{O}_5\text{-C4}$  precursors.