

Supporting Information

Metal-free chemical vapour deposition growth of graphitic tubular structures on engineered perovskite oxide substrates

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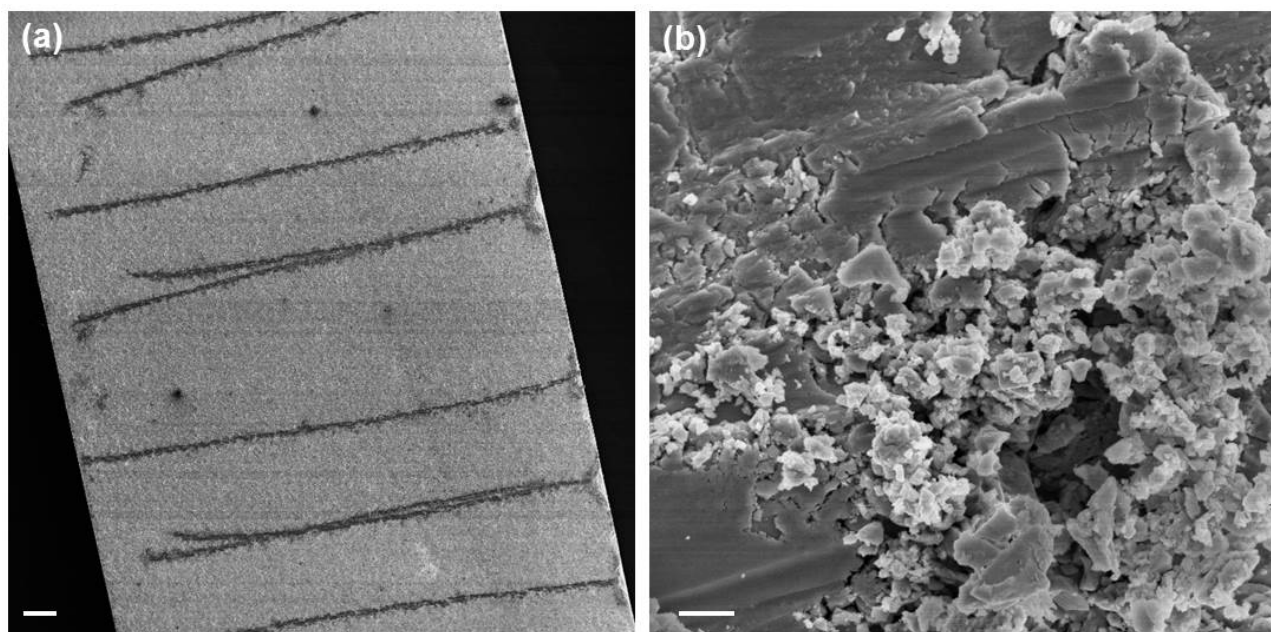


Figure S1. SEM observation of scratched SrTiO₃ (001) substrates prior to CVD reaction. (a) A low magnification image shows the scratching marks on the surface. Scale bar: 100 μm . (b) A view of the surface morphology in the area of one of these scratches, indicating that micro- and nano-sized particles are present. Scale bar: 1 μm .

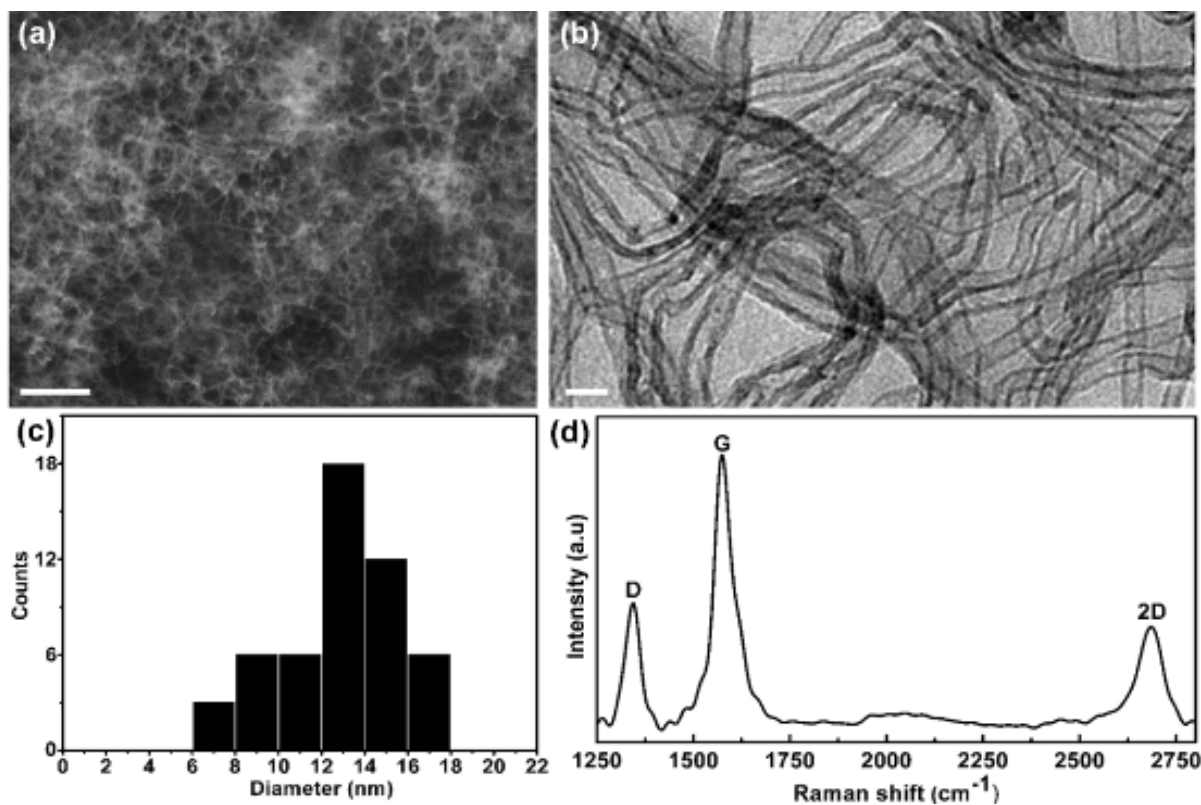


Figure S2. Detailed characterisation of CNT/Fs grown on sputtered SrTiO₃ (001) surfaces. Typical (a) SEM and (b) TEM images of as-grown CNT/Fs by EtOH-CVD at 700°C. (c) Diameter distribution of as-grown CNT/Fs. (d) Representative Raman spectrum of the obtained CNT/Fs. Scale bars: (a) 200 nm. (b) 20 nm.

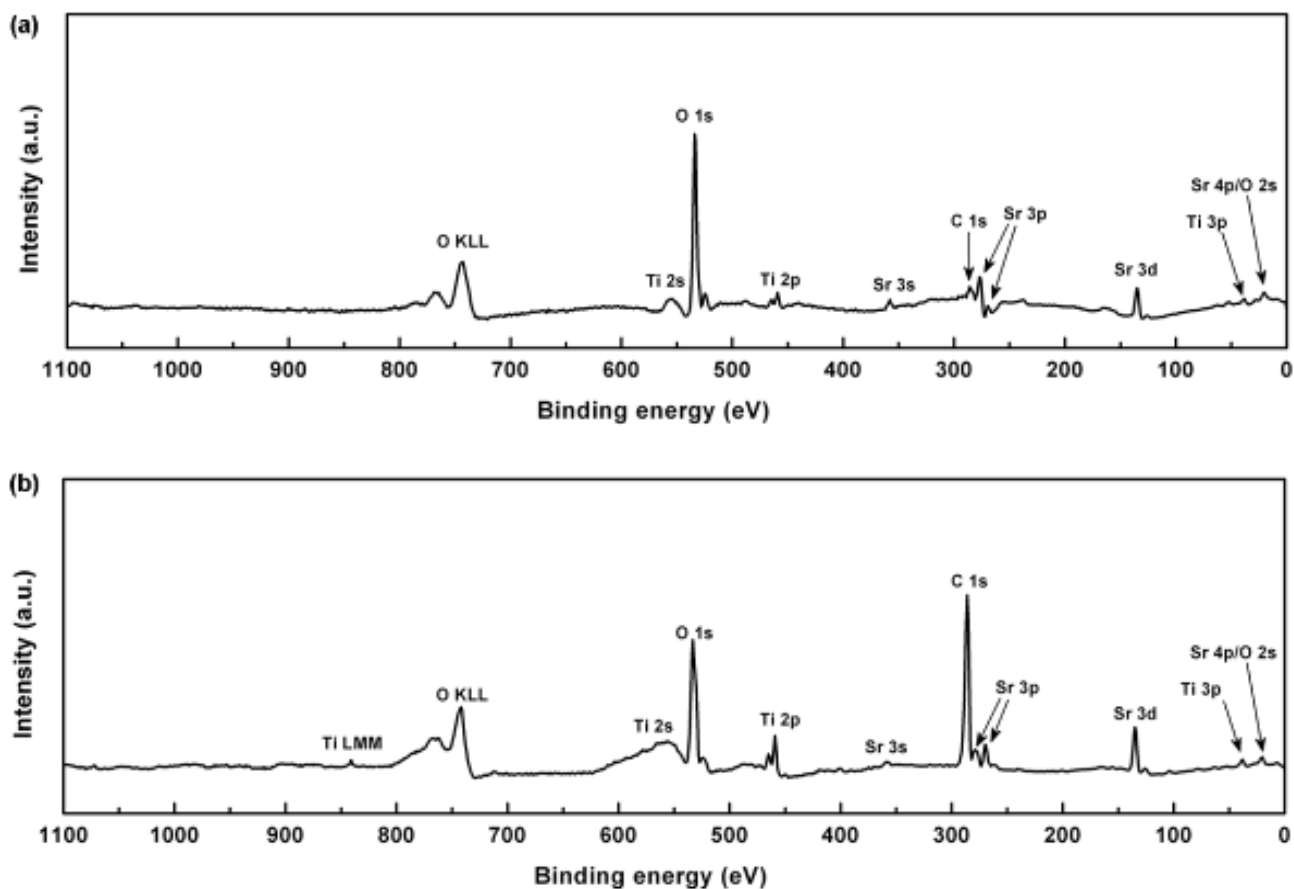


Figure S3. Elemental analysis of as-treated and post-grown sputtered SrTiO₃ (001) samples. XPS measurement of the sputtered sample surface (a) prior to and (b) after a CVD reaction, revealing that the substrate is free of metallic contaminations (Fe, Co, Ni *etc.*).

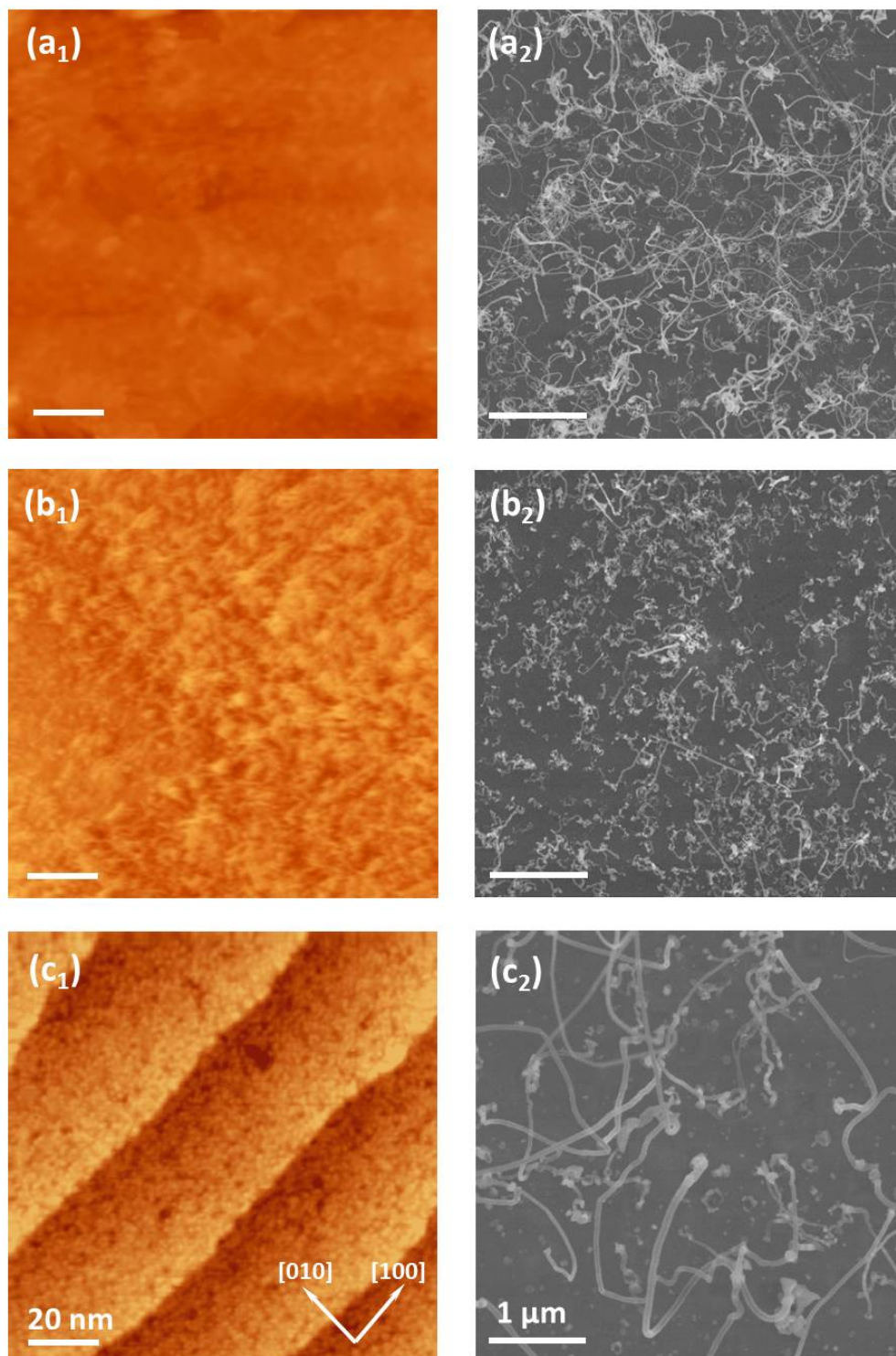


Figure S4. Image library of surface-roughness-tailored growth of CNT/Fs on a series of SrTiO₃ (001) substrates by direct EtOH-CVD. (a₁-c₁) STM images of (a₁) BHF-etched, (b₁) degassed and (c₁) (2×1)-reconstructed substrates. Scale bars: 20 nm. (a₂-c₂) SEM observations of CNT/Fs grown on the corresponding SrTiO₃ substrates. Scale bars: 1 μm.

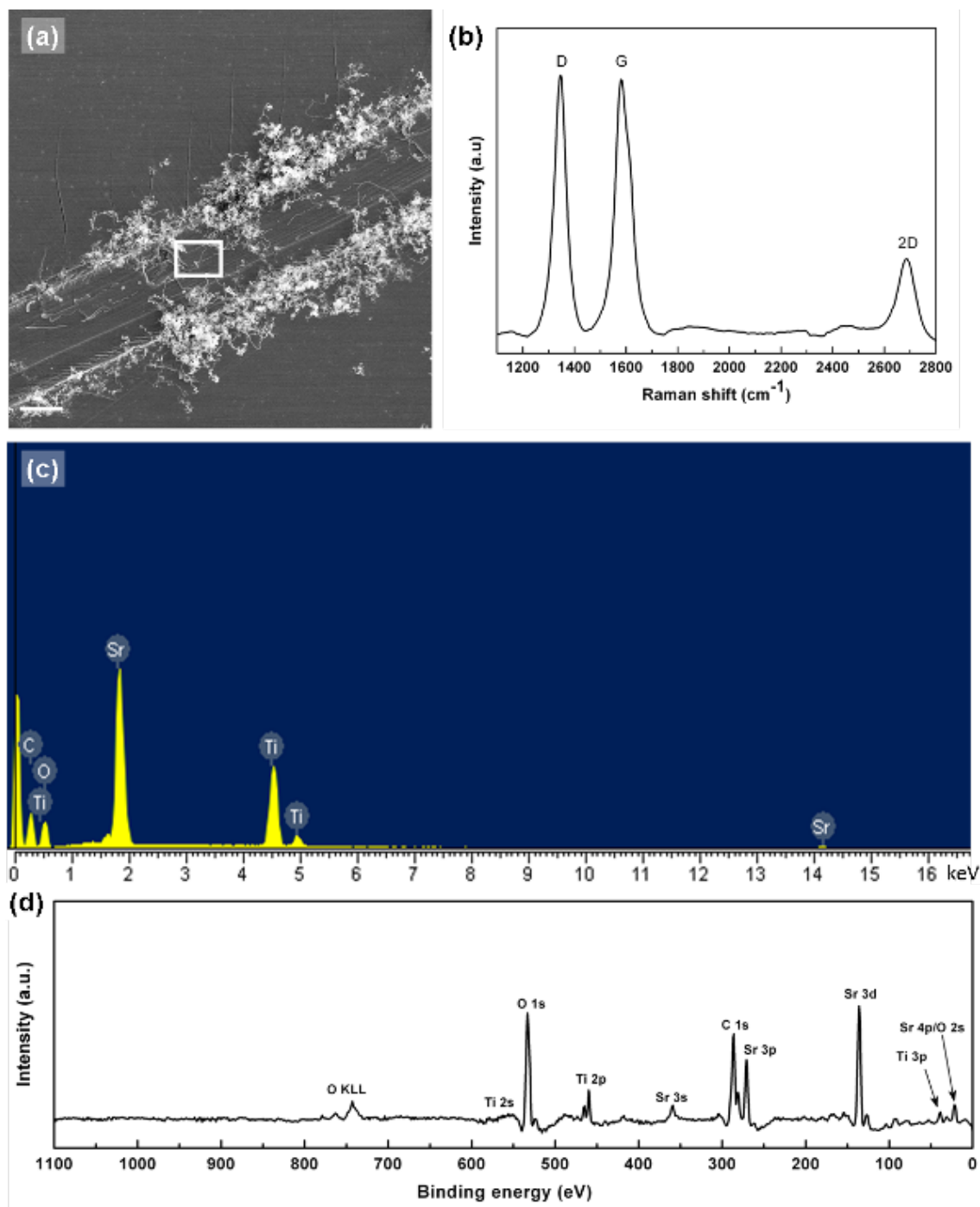


Figure S5. Characterization of CNT/Fs grown on scratched SrTiO₃ surfaces by EtOH-CVD at a growth temperature of 700°C. (a) SEM observation showing the appearance of CNT/Fs generated alongside the scratching mark. Scale bar: 3 μm . (b) Raman spectrum of the CNT/Fs shown in (a). (c) EDX pattern generated from the white box in (a). (d) Survey XPS spectrum of the substrate after CVD growth.

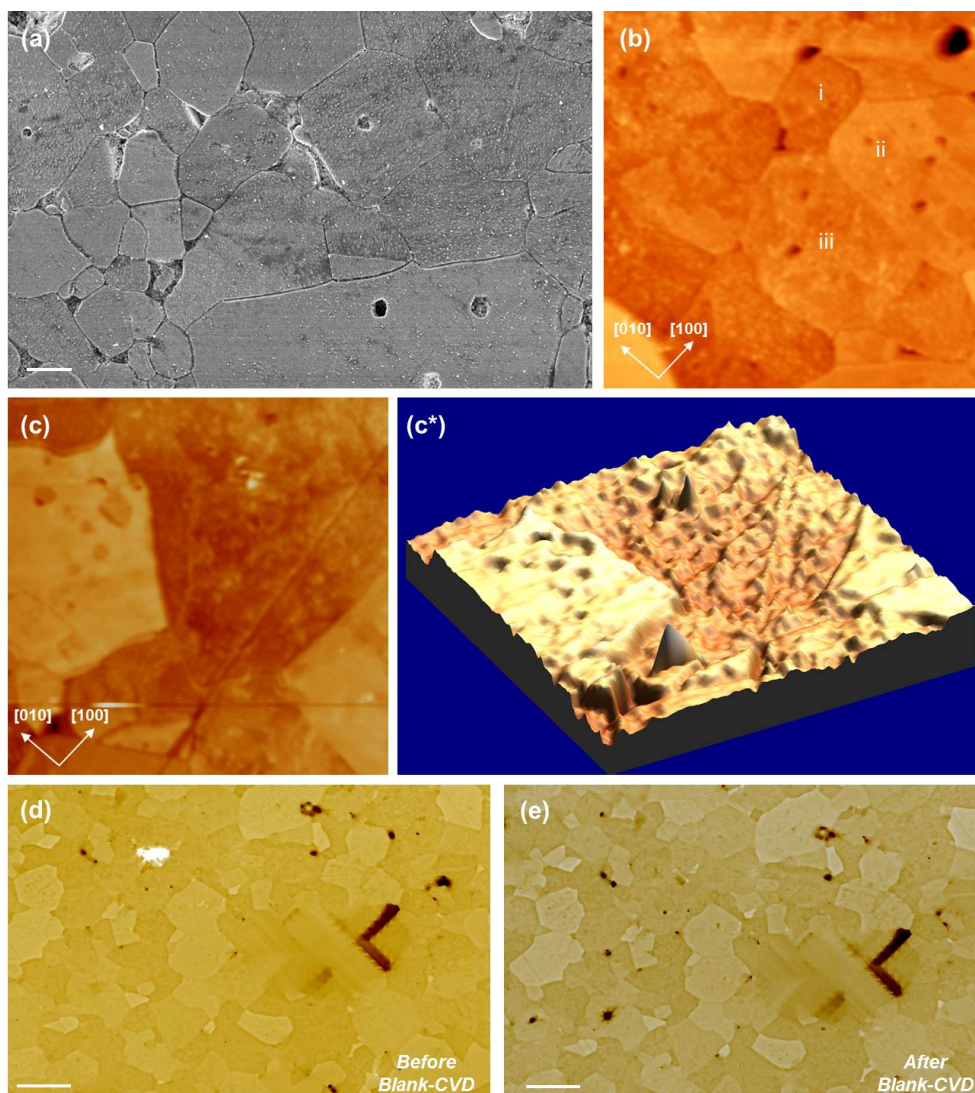


Figure S6. Structural characterization of the etched $\text{Ba}_{0.6}\text{Sr}_{0.4}\text{TiO}_3$ polycrystalline sample. (a) Representative SEM image of BHF-etched BST surface prior to the CVD process. The different crystal facets, along with the phenomenon of grain boundary grooving, can be clearly observed. Scale bar: 1 μm . (b) AFM image of the etched BST surface prior to the CVD process. The distinct crystal facets are marked as 'i', 'ii', and 'iii' in the image. (Image size: $30 \times 30 \mu\text{m}^2$). (c) AFM image and (c*) corresponding 3D view of the etched BST surface prior to the CVD process, showing various surface facets (with different heights and features). (Image size: $20 \times 20 \mu\text{m}^2$). (d-e) Micro-XAM imaging of the same area of the etched BST surface (d) prior to and (e) after a blank-CVD process, indicating that the CVD process itself does not cause surface structural changes. A blank CVD process is where no carbon feedstock is added to the carrier gas. Scale bars: (d) and (e) 30 μm .

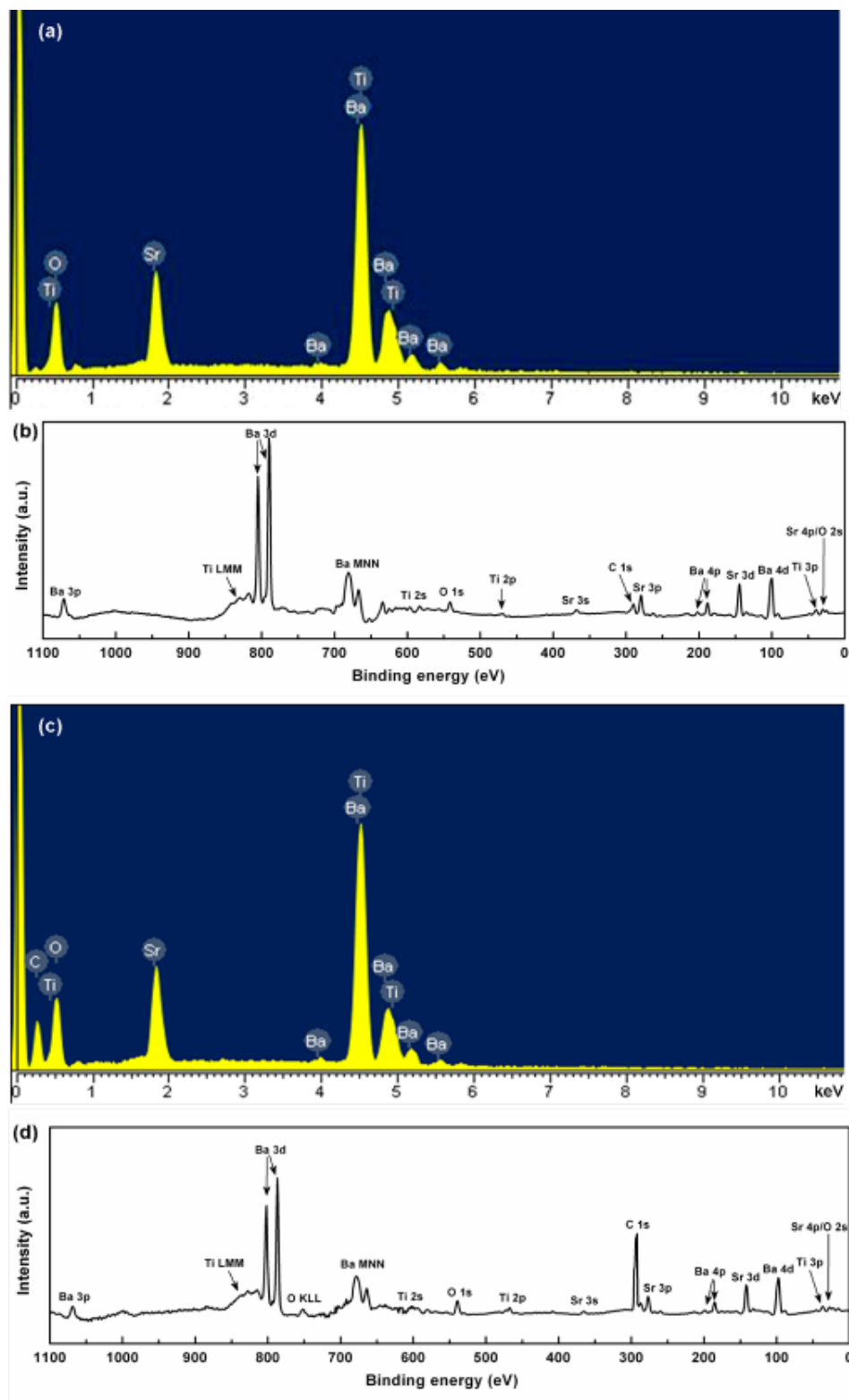


Figure S7. Elemental analysis of etched and post-grown BaSrTiO₃ polycrystalline samples. Representative (a, c) EDX and (b, d) XPS measurements of BHF-etched BST surfaces (a, b) prior to and (c, d) after CVD reactions, revealing that the substrate is free of metallic contaminations (Fe, Co, Ni, etc.).