

Supplementary Information for

Remote epitaxy of $K_{0.5}Na_{0.5}NbO_3$ films on $SrTiO_3$

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Supplementary information

Section I. Growth technique

As shown in Figure S1, the detail process is following:

1. the polymethyl methacrylate (PMMA) is coating on the commercial graphene grown on copper foils.
2. it is placed into $FeCl_3$ solution (1 mol/L) for 1 hour and the copper foils are etched. Then the PMMA/graphene is washed in DI water for 10 minutes and transferred on STO substrates.
3. the PMMA is removed in acetone for 1 hours.
4. then the graphene/STO is placed into PLD with a base pressure of $<1 \times 10^{-4}$ Pa. The substrates were pre-annealed at $680^\circ C$ at the base pressure for 10 minutes (min) to remove the possible surface contamination.
5. Finally the KNN films were grown at $680^\circ C$ under an oxygen partial pressure of 30 Pa, using a stoichiometric KNN ceramic target and a 248 nm KrF laser with a frequency of 3 Hz. The laser energy density was $1.8 J/cm^2$ and the target-substrate distance was ~ 4.2 cm.

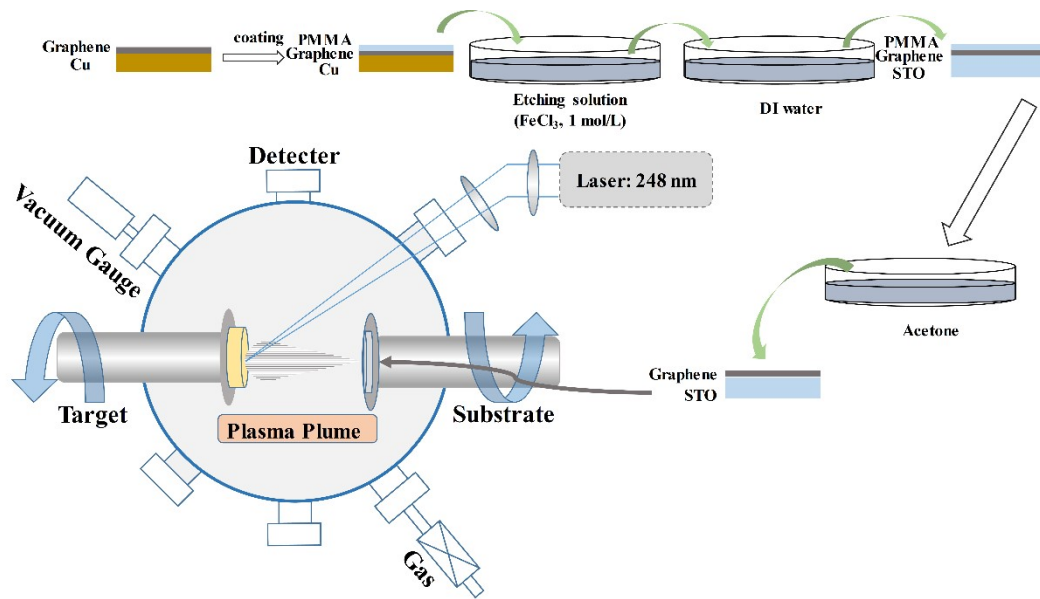


Figure S1. The schematic presentation for the growth technique.

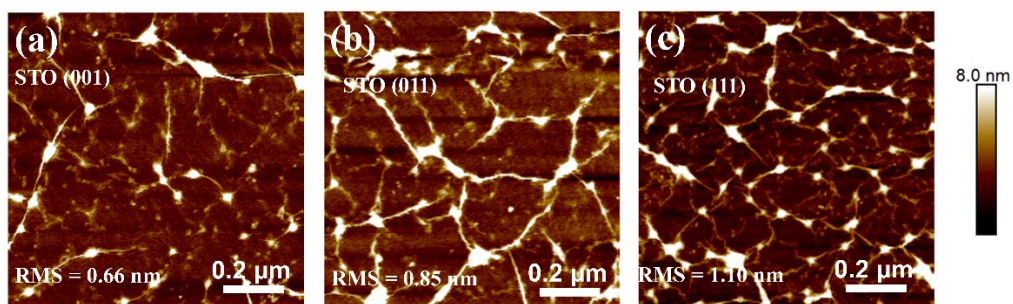


Figure S2. AFM images of G-STO (001) (a), (011) (b), (111) (c) after annealing respectively.

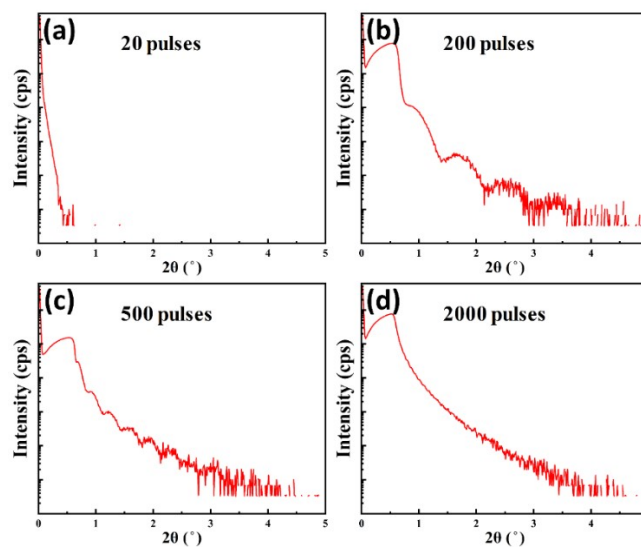


Figure S3. X-ray reflectivity (XRR) of KNN films grown on G-STO substrate with different pulse numbers, (a) 20 PLD laser pulses (1.1 nm), (b) 200 PLD laser pulses (11 nm), (c) 500 PLD laser pulses (29 nm), and (e) 2000 PLD laser pulses (110 nm) respectively.

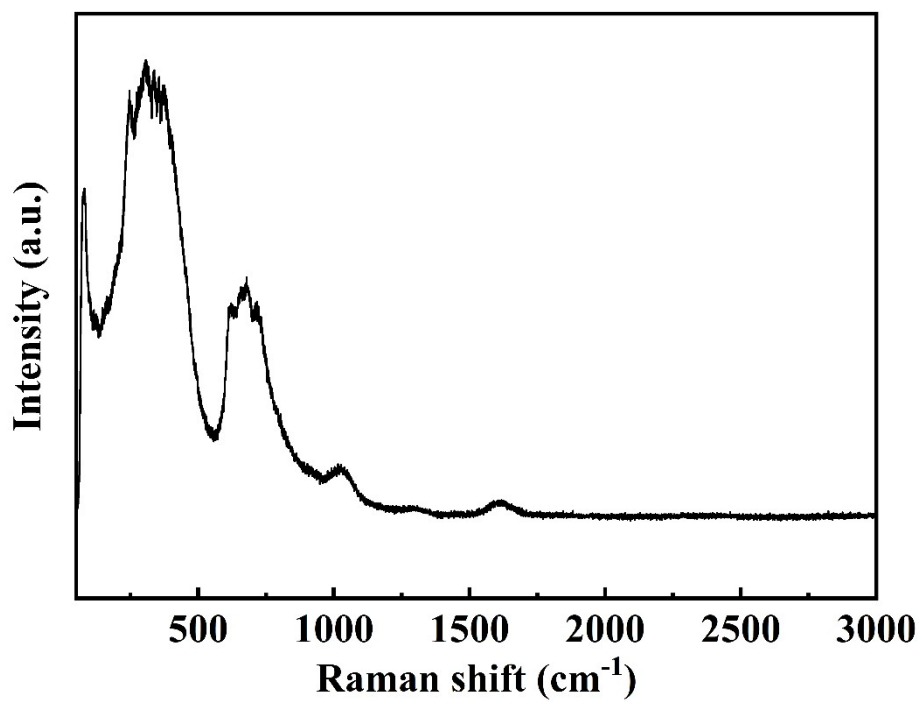


Figure S4. The Raman of STO substrate without transferred graphene.

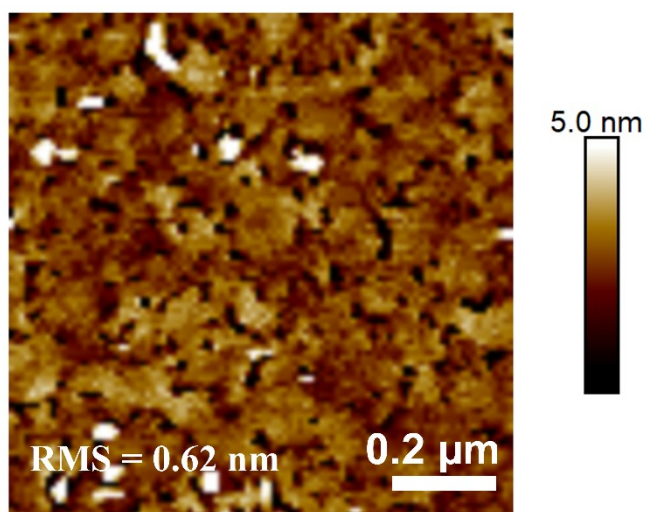


Figure S5. AFM images of KNN on G-STO (001).

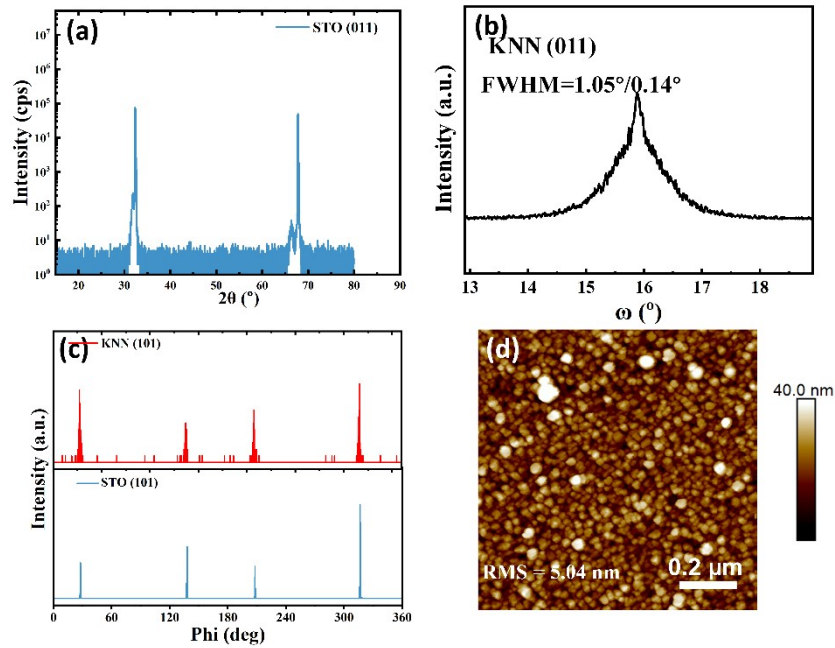


Figure S6. (a) Specular out-of-plane XRD patterns, (b) Rocking curves of KNN (011) peak, (c) Phi scan of KNN (101) and STO (101), (d) AFM image of KNN grown on direct STO (011).

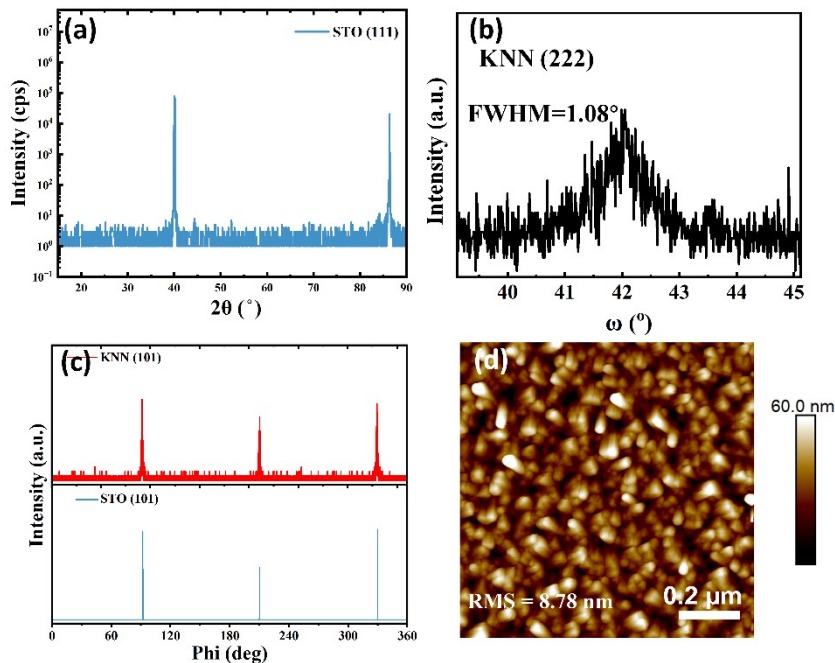


Figure S7. (a) Specular out-of-plane XRD patterns, (b) Rocking curves of KNN (222) peak, (c) Phi scan of KNN (101) and STO (101), (d) AFM image of KNN grown on direct STO (011).