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Supporting Information

Atomic layer deposition of HfN_x films and improving the film performance by annealing under NH_3 atmosphere

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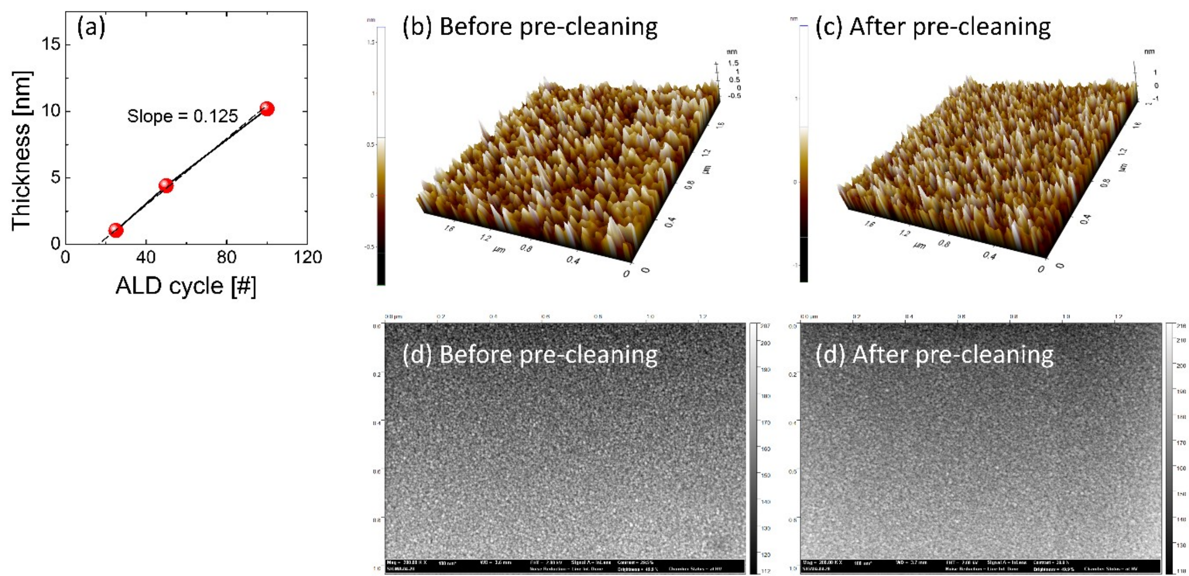

Figure S1. (a) Increasing thickness of HfN_x film with ALD cycle deposited without precleaning step, AFM image of TiN (b) before and (c) after precleaning step. SEM image of TiN (d) before and after (e) precleaned TiN.

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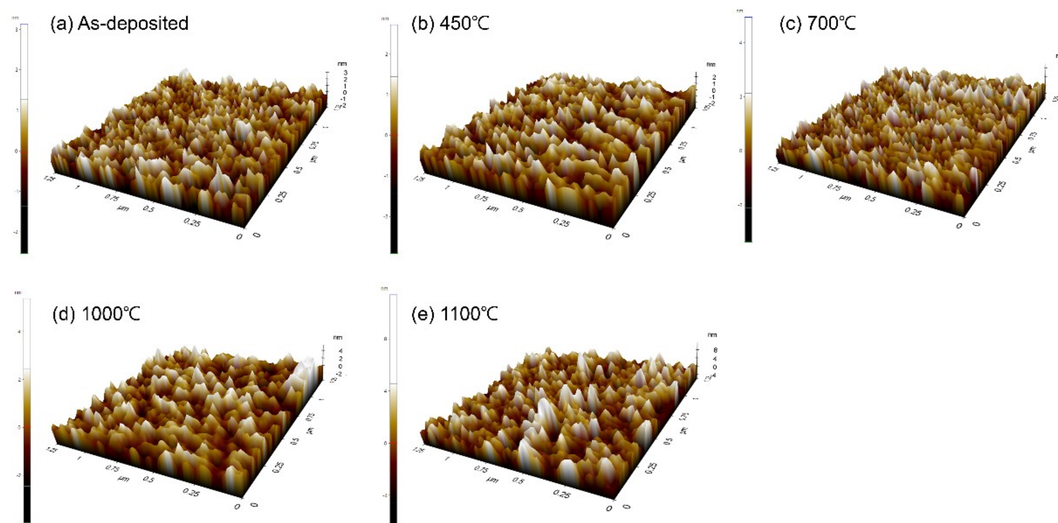

Figure S2. The AFM images of HfN_x film, annealed under different temperatures. All films were deposited with the precleaning step.

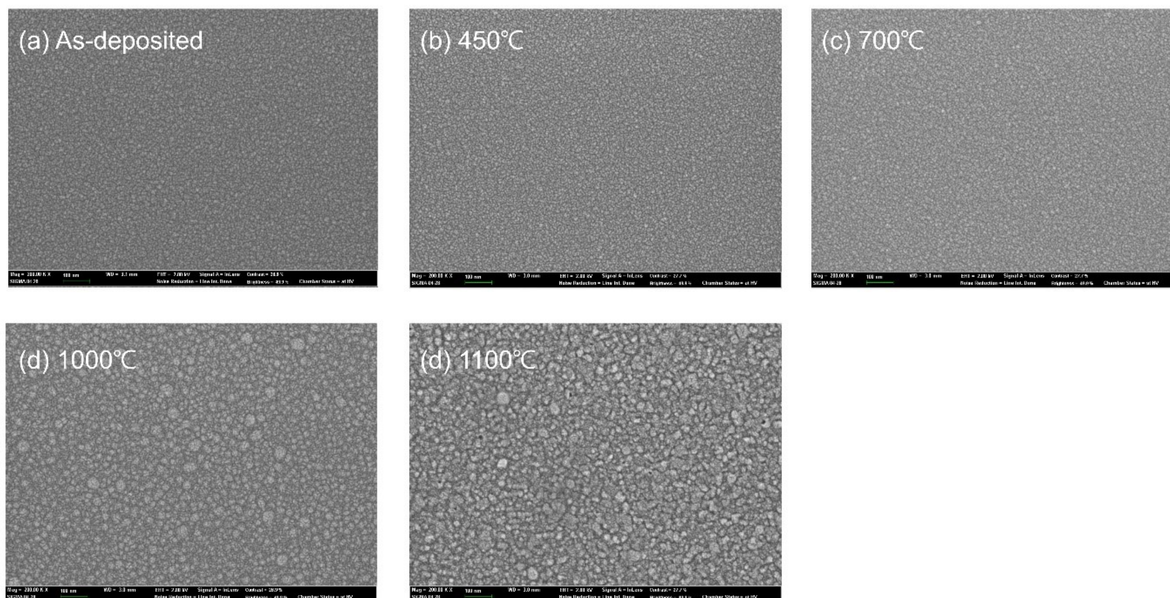

Figure S3. Scanning electron microscopy(SEM) image of HfN_x film annealed under different temperatures. All films were deposited with the precleaning step.

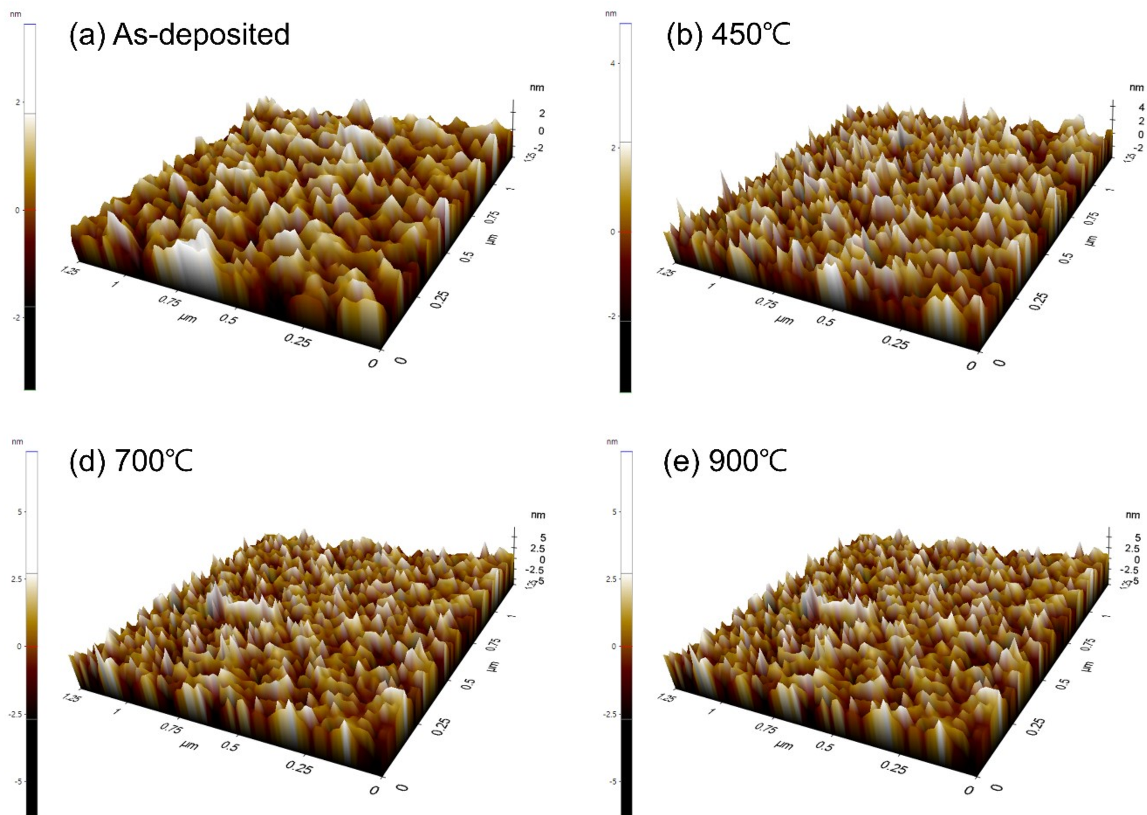

Figure S4. The AFM images of HfN_x film, annealed under different temperatures. All films were deposited without the precleaning step.

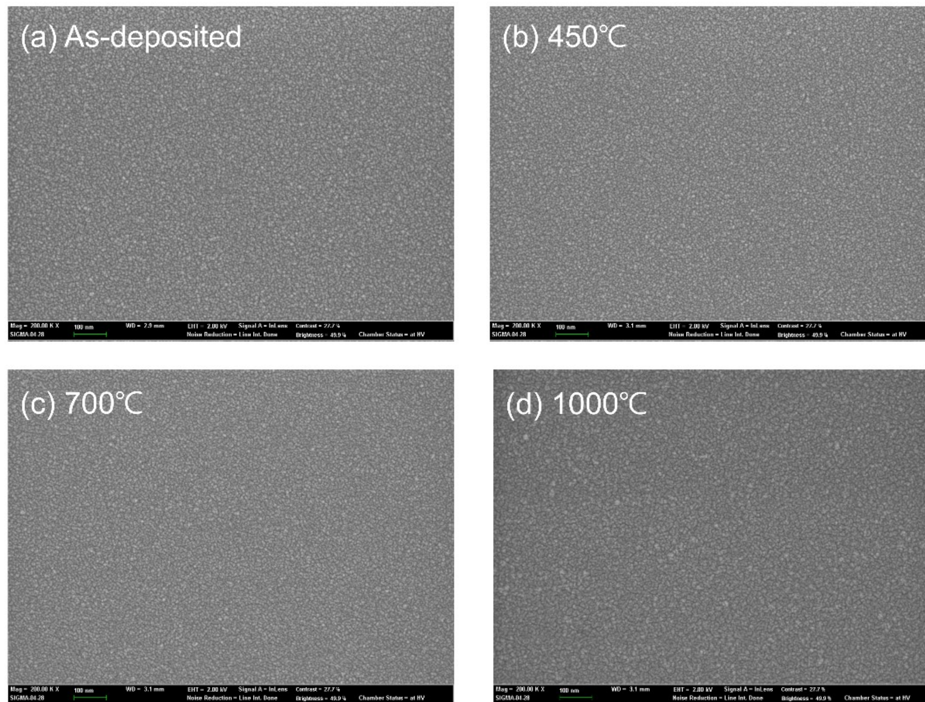

Figure S5. SEM image of HfN_x film annealed under different temperatures. All films were deposited without the precleaning step.

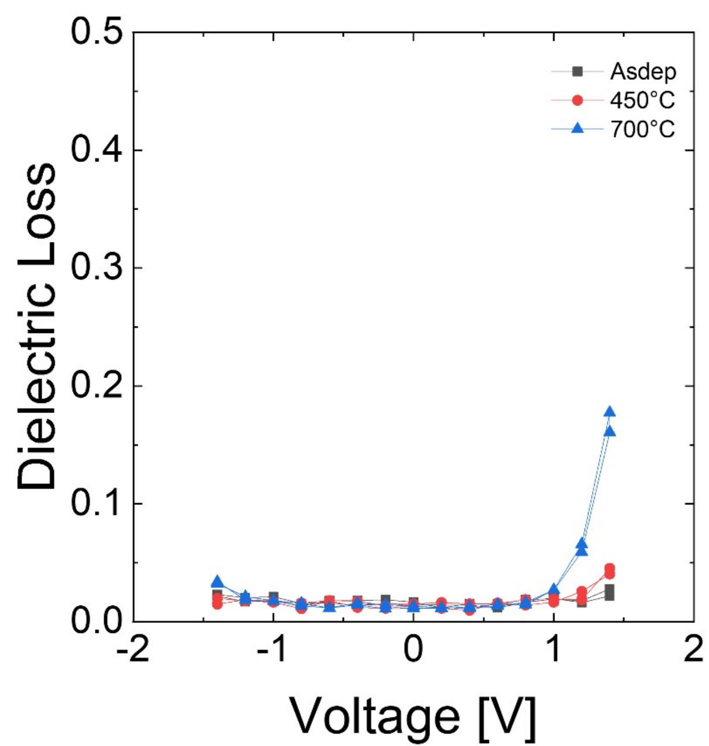

Figure S6. Dielectric loss of HfN_x film annealed under different temperatures.