



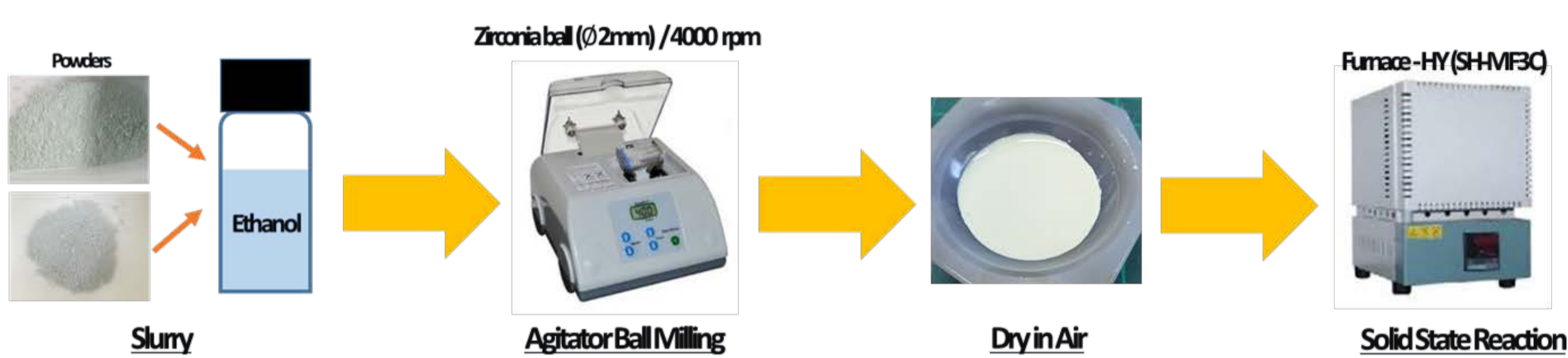
Introduction

High-resolution X-ray imaging system is composed of a scintillator and an optical detector coupled with lens. Spatial resolution is the one of most important parameters of high-resolution X-ray imaging. When this optical detector has an effective pixel size from nano to micro meter, X-ray images are developed with micron spatial resolution. However, spatial resolution of this system is affected by the structure of a scintillator because the optical detector coupled with lens is highly sensitive to the optical diffusion phenomenon caused by the scintillator structure.

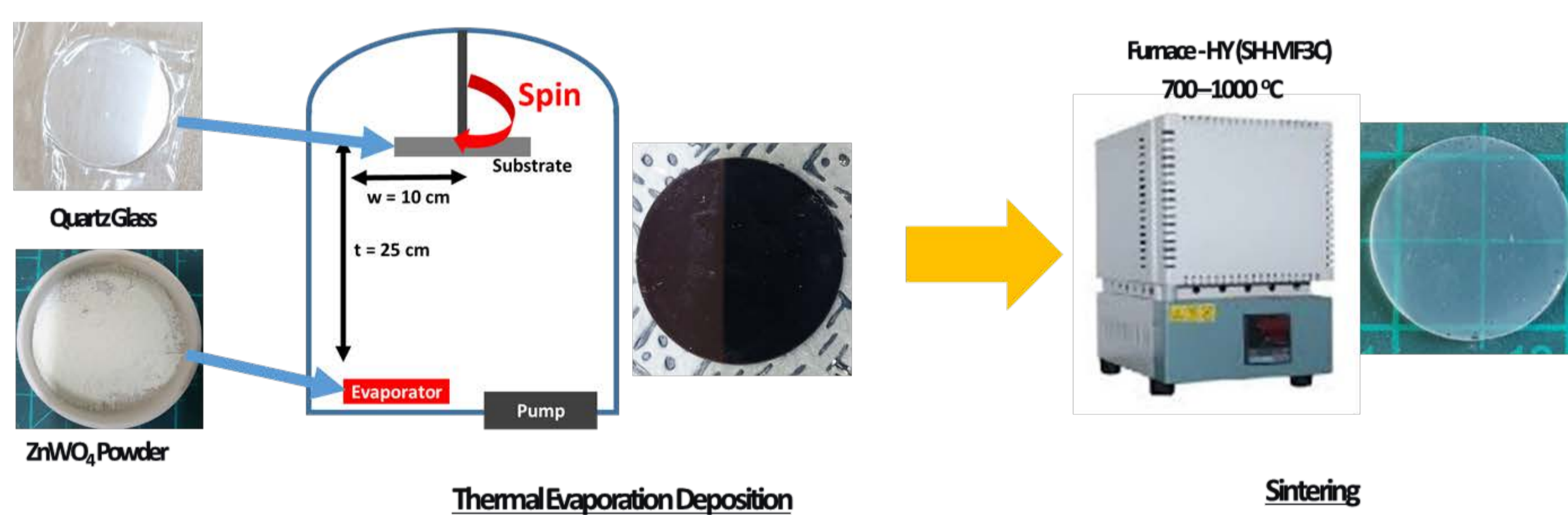
In this study, nano-grained zinc tungstate (ZnWO₄) was used for the thin-layer transparent film scintillator on quartz glass using the thermal evaporating deposition method. ZnWO₄ has been used for a long time as an X-ray scintillator. [1] For this reason, ZnWO₄ has 2.3 times more luminescence characteristics under X-ray irradiation than commonly used Bi₄Ge₃O₁₂ (BGO). [2] In addition, the material is high density ($\rho = 7.87 \text{ g/cm}^3$), high effective atomic number ($Z_{\text{eff}} = 61$), short decay time, high stability and economical price. [3] Since ZnWO₄ has high X-ray absorption capability relative to ρZ_{eff} , it has the potential to be utilized in thin film scintillators used for high-resolution X-ray imaging. ZnWO₄ can be easily utilized in the thermal evaporating deposition method because it has a relatively low melting point ($\sim 1166 \text{ }^\circ\text{C}$). [1] For the above reasons, we demonstrated that thermal evaporating deposition method can easily fabricate thin-layer transparent nano-grained ZnWO₄ film.

Experimental

Fabrication of ZnWO₄ Powder

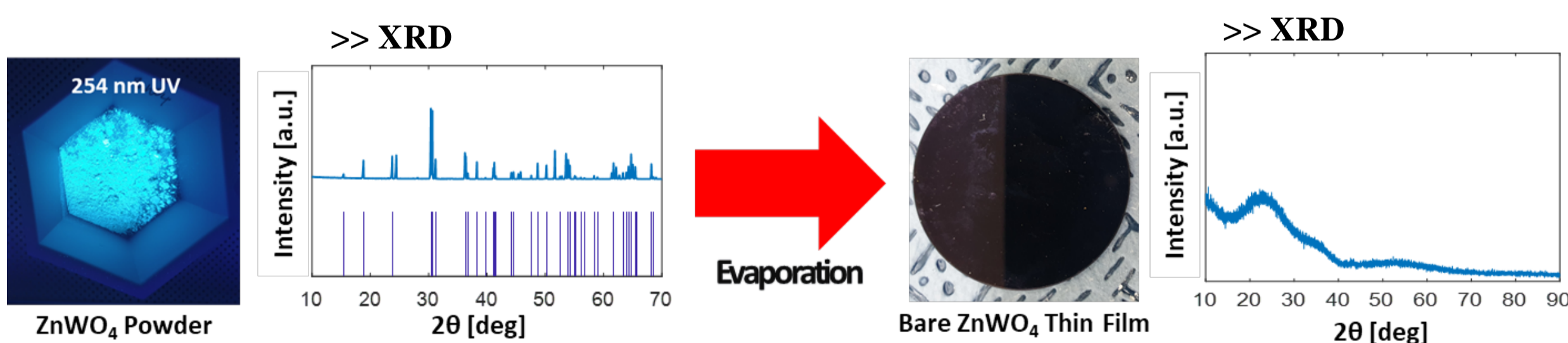


Fabrication of Transparent ZnWO₄ Thin Film



Results

Thermal Evaporating Deposition

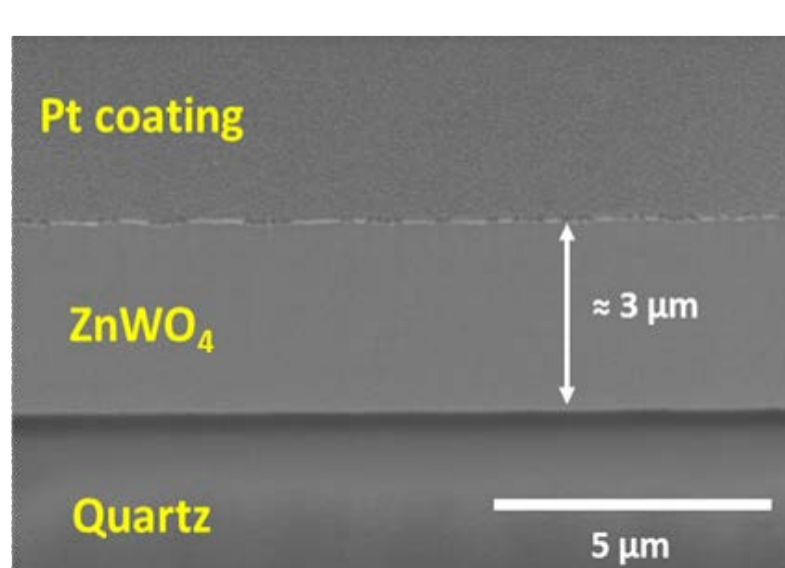


Crystallized ZnWO₄

No Peak (Amorphous)

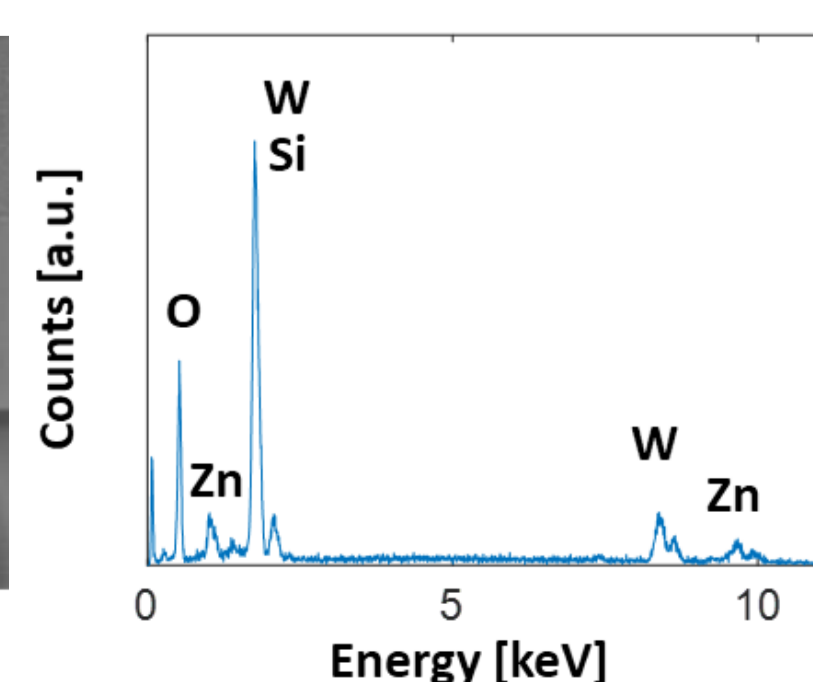
Characterization of Evaporated ZnWO₄ Thin Film

>> FIB with SEM



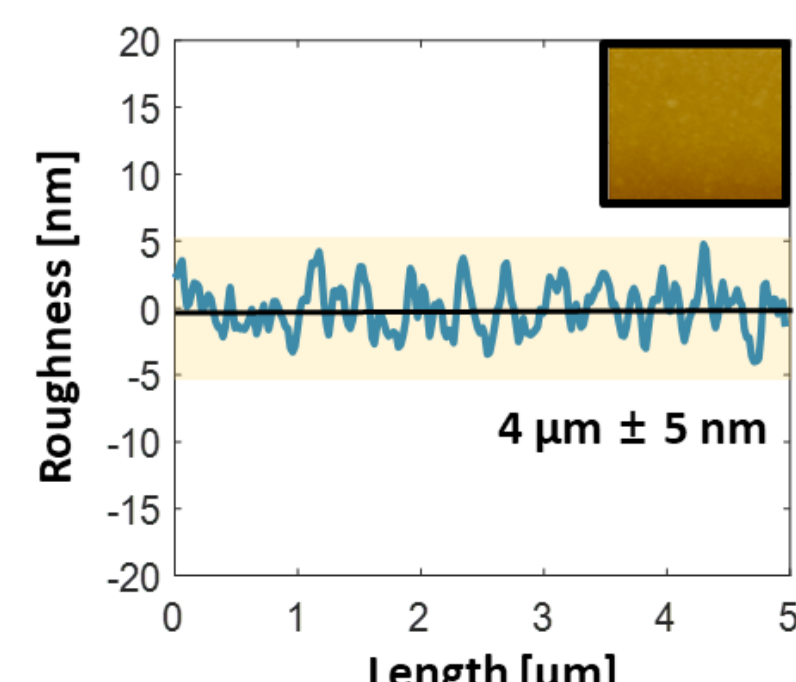
3 μm Thickness

>> EDX



Composed of Zn, W, O

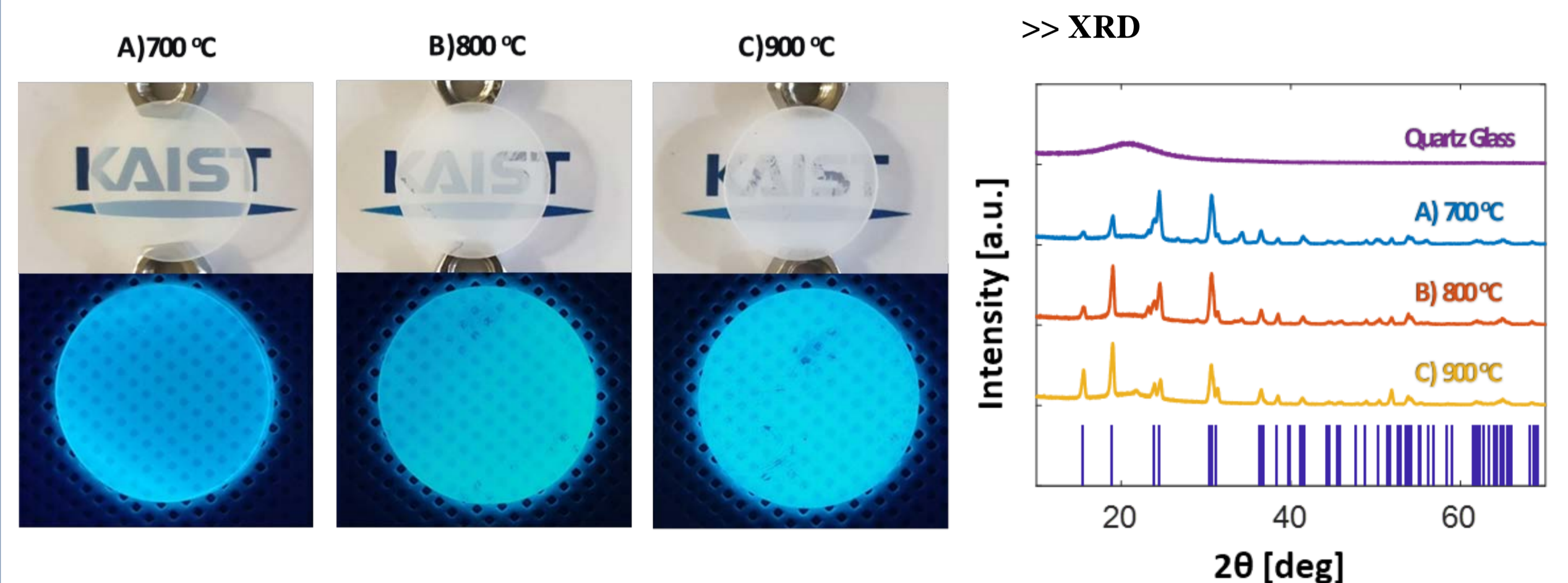
>> AFM



High Uniformity

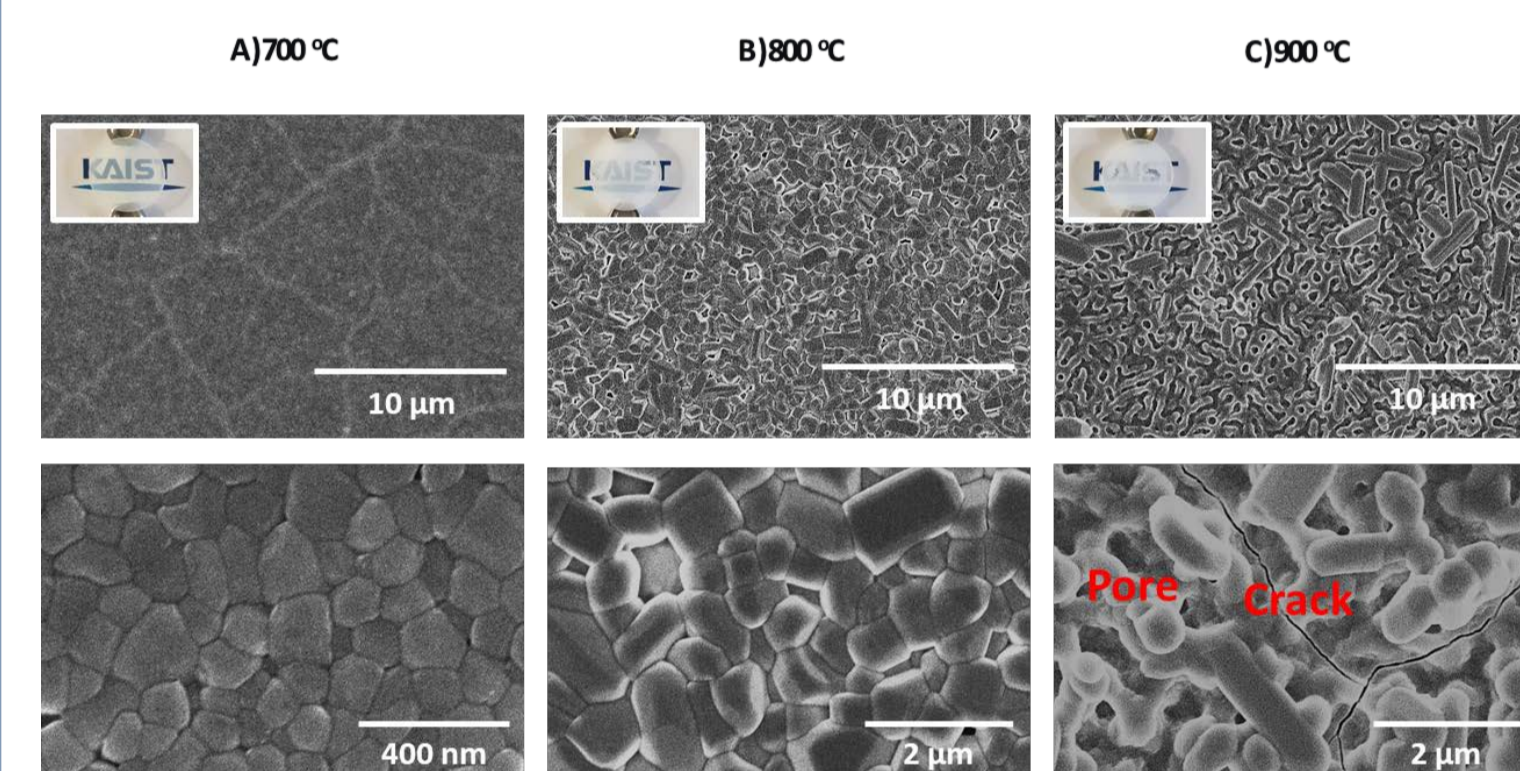
Results

Sintered ZnWO₄ Thin Film

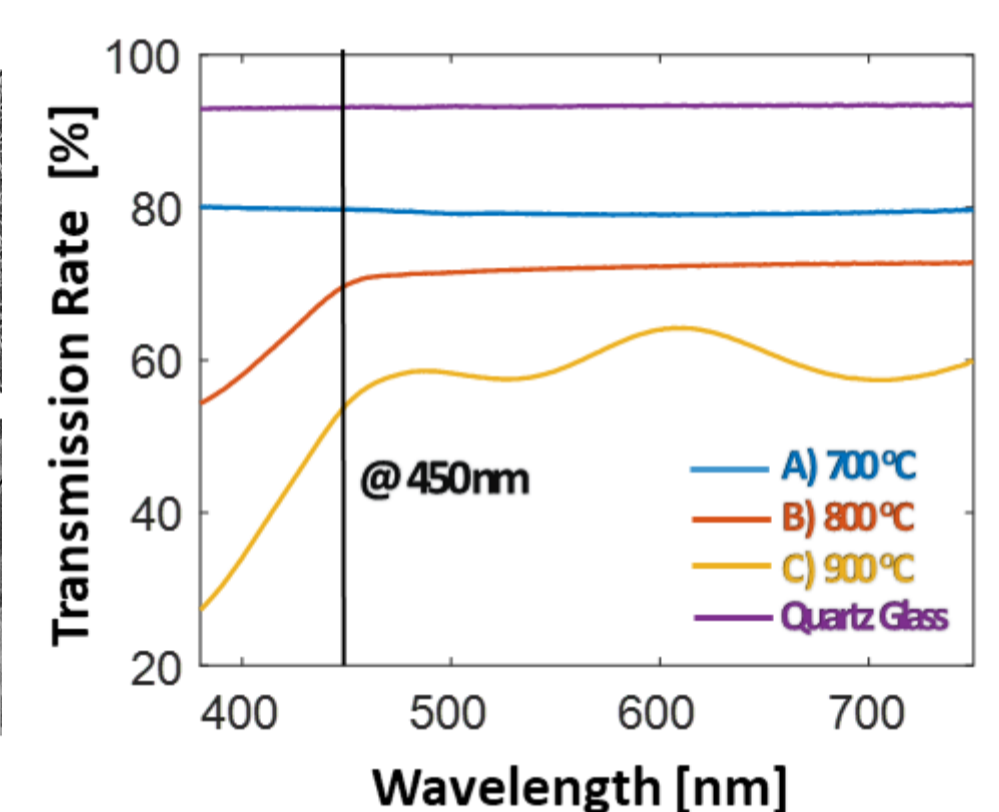


Characterization of Sintered ZnWO₄ Thin Film

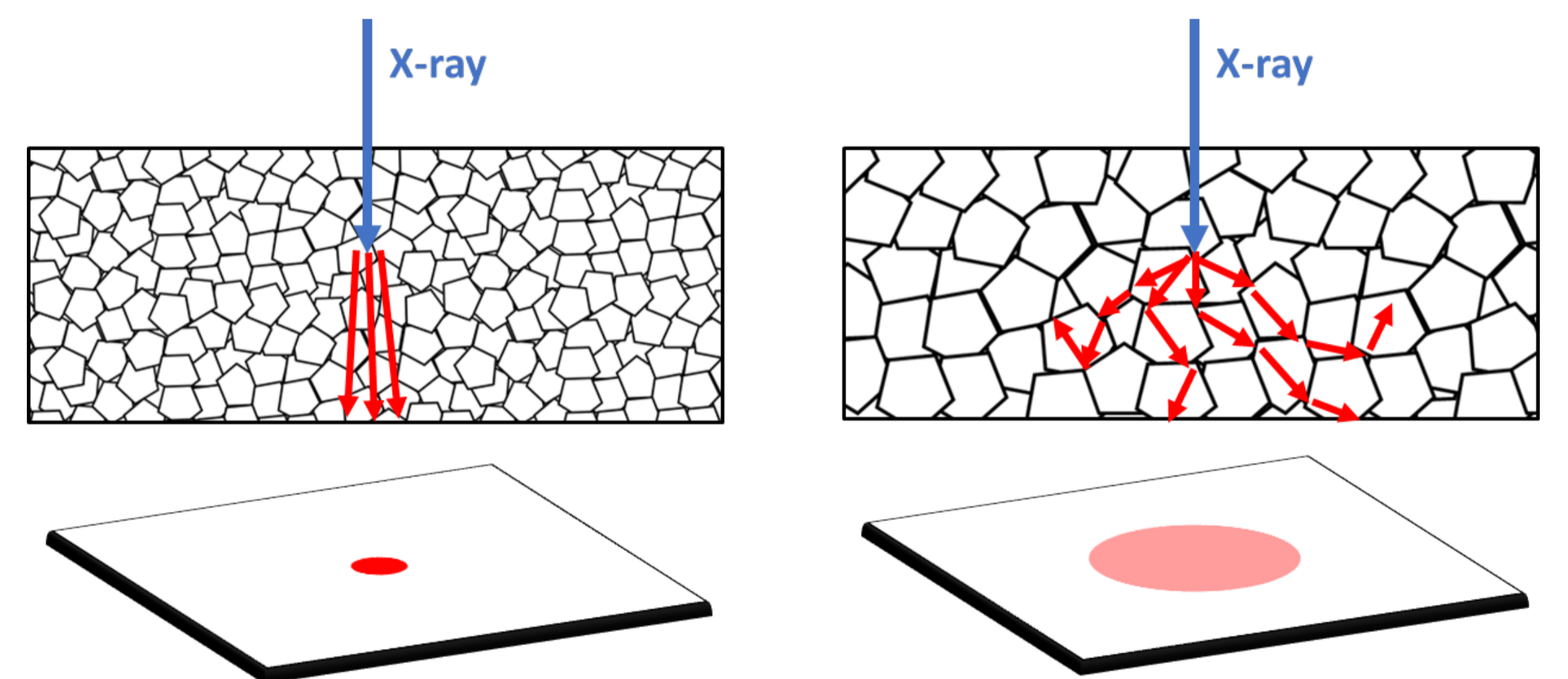
>> SEM Image



>> Transmission Rate



The effect of Grain Size of scintillator in X-ray Imaging



Smaller Grained Scintillator → Higher Spatial Resolution X-ray Image

Conclusion

We have demonstrated nano-grained thin-layer transparent film can be fabricated by thermal evaporating deposition method. Since it has a nano-grained structure, mie-scattering for optical light is minimized. Therefore, the optimized ZnWO₄ scintillator film has high optical property. These results indicated that nano-grained ZnWO₄ thin film scintillator fabricated by thermal evaporating deposition method is expected to be used effectively in the field of high-resolution X-ray imaging.



Reference

- [1] Touš, J.; Blažek, K.; Pina, L.; Sopko, B. High-resolution X-ray imaging CCD camera based on a thin scintillator screen. Radiation measurements 2007, 42, 925-928.
- [2] Touš, J.; Horvath, M.; Pina, L.; Blažek, K.; Sopko, B. High-resolution application of YAG: Ce and LuAG: Ce imaging detectors with a CCD X-ray camera. Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment 2008, 591, 264-267.
- [3] Buryi, M.; Laguta, V.; Nikl, M.; Gorbenko, V.; Zorenko, T.; Zorenko, Y. LPE growth and study of the Ce³⁺ incorporation in LuAlO₃: Ce single crystalline film scintillators. CrystEngComm 2019, 21, 3313-3321.