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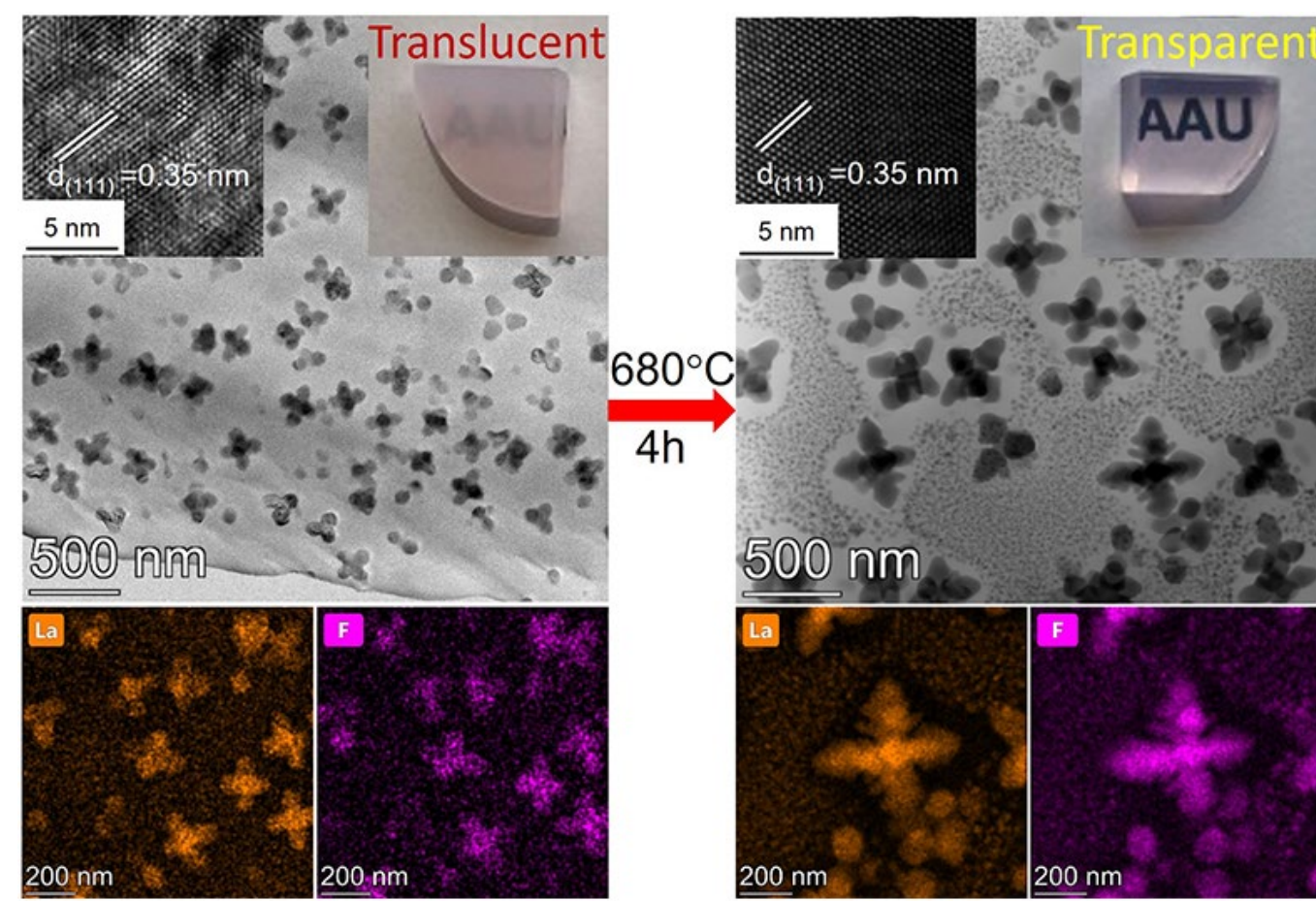
Making Transparent Er³⁺-Yb³⁺ Ions Doped Oxyfluoride Glass-Ceramics with Enhanced Luminescence via heat-treatment

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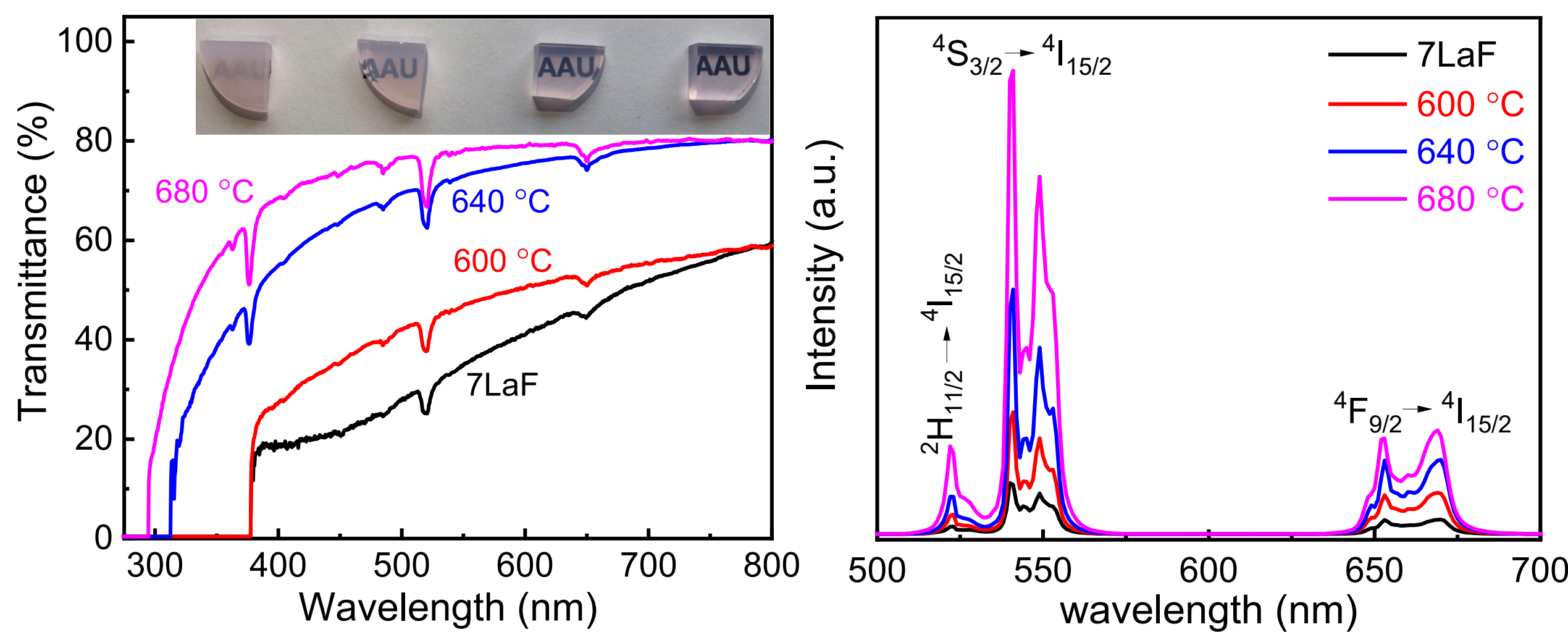
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Abstract

It is known that the optical transparency of an oxide glass decreases with an increase of the size and fraction of crystals in the glass during heat-treatment (HT). Here we report an opposite scenario, where a translucent Er³⁺-Yb³⁺ doped oxyfluoride glass-ceramic (GC) becomes transparent with increasing crystal size and crystallinity. Specifically, in the heat-treated GC samples, we observed that the growth of the existing Ba₂LaF₇ crystals and particularly the formation of small spherical Ba₂LaF₇ crystals greatly enhanced the light transmittance. The results show that the composition of the residual glass phase was altered (e.g., depletion of F⁻ and La³⁺) in the way that the differences in refractive index between the glass matrix and the crystals are greatly reduced. As a consequence, the light scattering of the heat-treated GC was suppressed, and hence, the derived GC became transparent. In addition, a proper HT can also enhance the luminescence of the studied GC system.

Light Transmittance and Up-conversion (UC) Luminescence



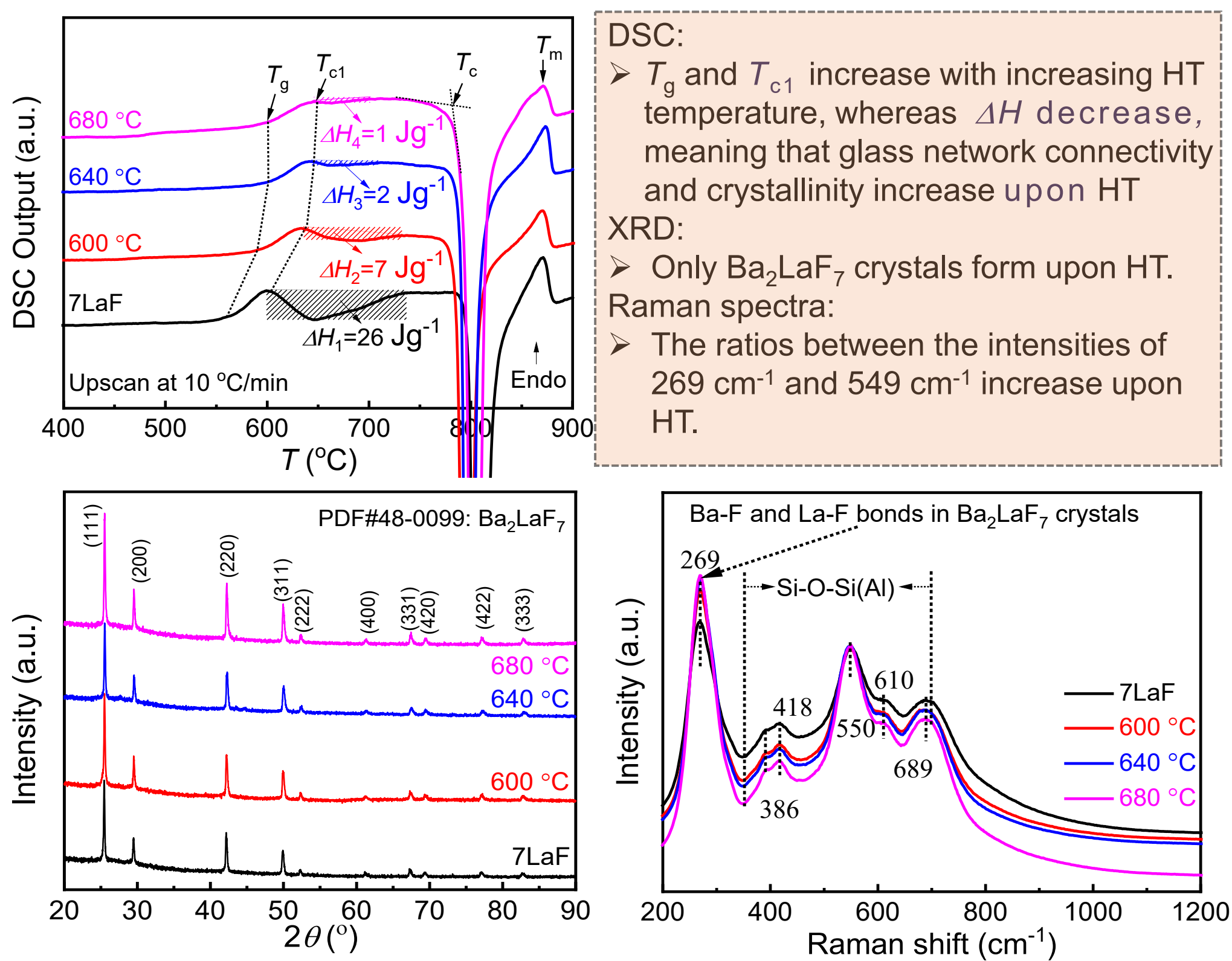
Light transmittance and UC Luminescence:

- Light transmittance increases upon HT.
- UC luminescence is 9 times higher than the 7LaF sample.

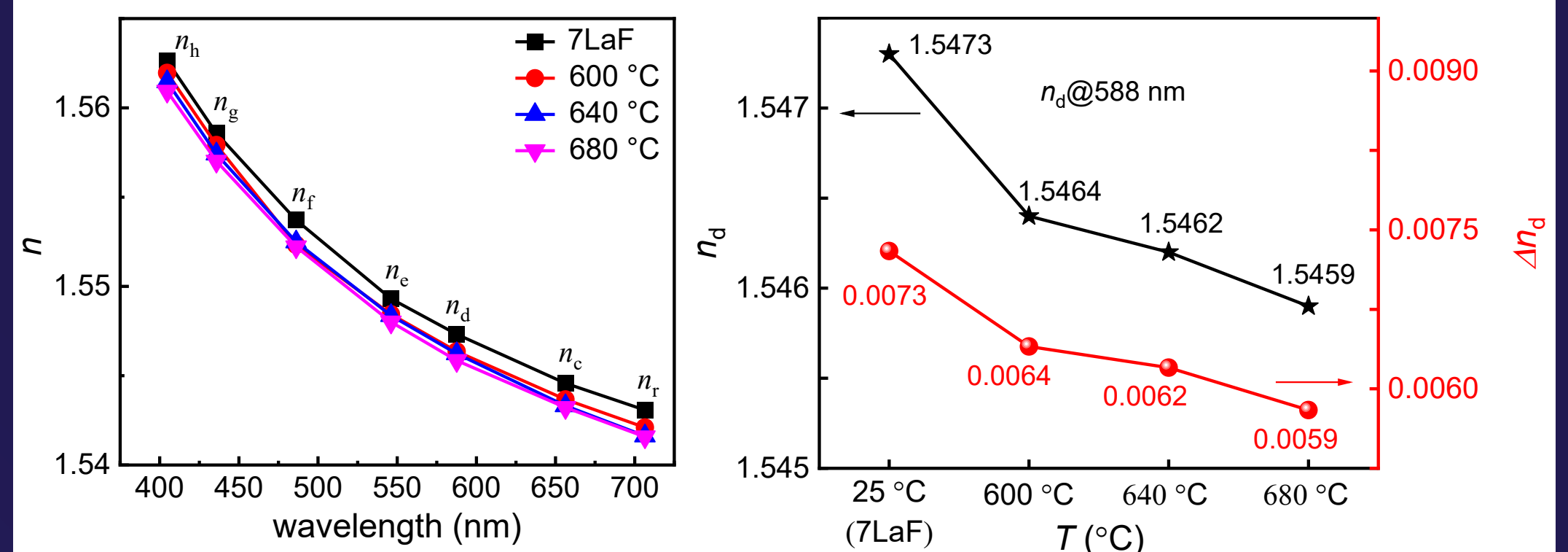
➤ **Two conditions for producing high transparent oxyfluoride GCs**

1. Nanocrystals should be considerably smaller (< 50 nm) than the wavelength of visible light
2. The difference in refractive index between nanocrystals and residual glass phase should be minimized (< 0.01) ★

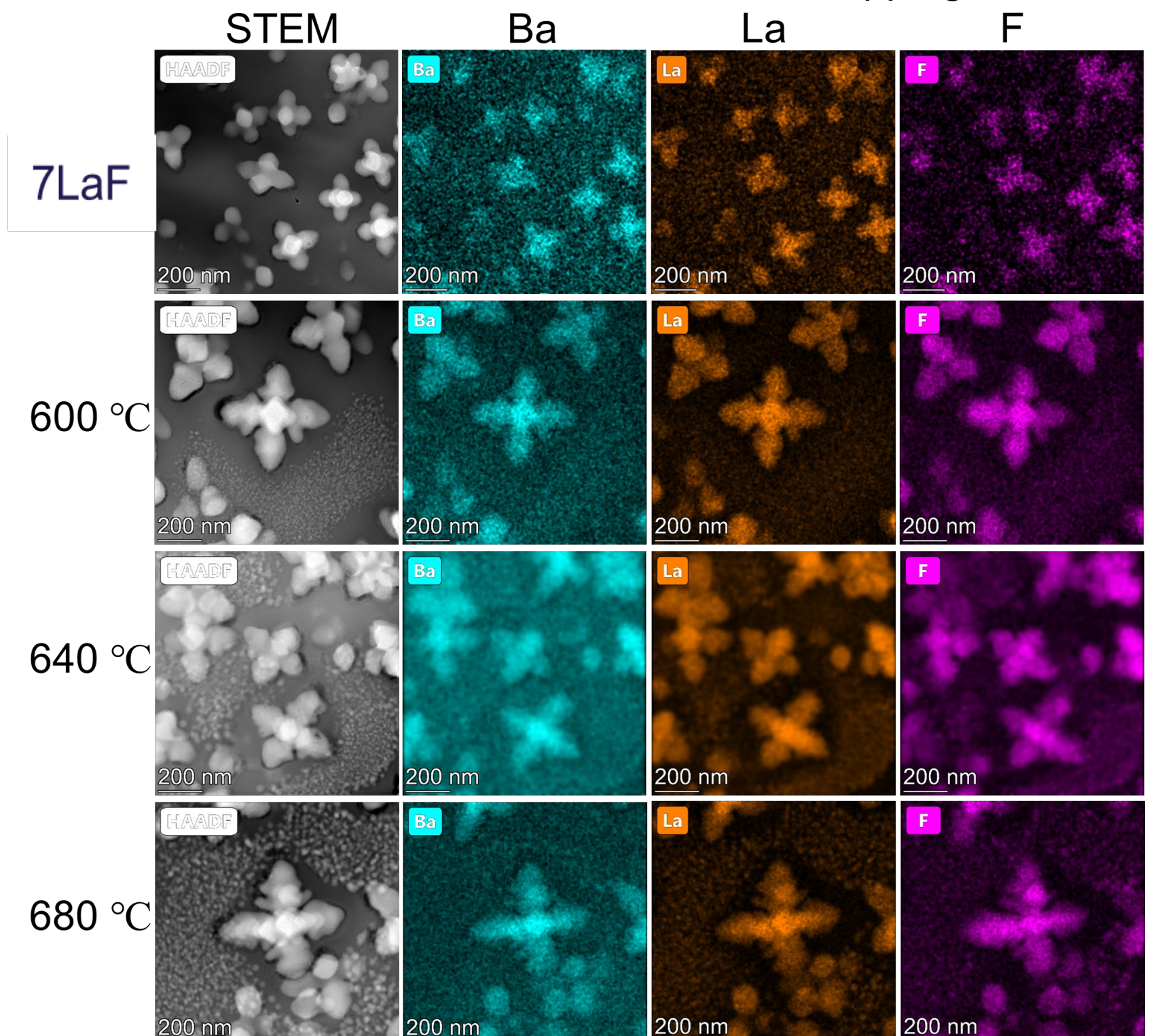
DSC, XRD and Raman spectroscopy Characterizations



Refractive Index and EDS Mapping Characterizations



HAADF STEM Elemental Mapping



Conclusions

- A translucent Er³⁺-Yb³⁺ doped oxyfluoride GC containing large flower-like Ba₂LaF₇ crystals is prepared via melt-quenching.
- The translucent oxyfluoride GC becomes transparent with increasing the crystal size and crystallinity as a result of HT, which is attributed to the suppression of the light scattering.
- The derived transparent GCs show strong UC luminescence.

Acknowledgements

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Refractive index (n):

- n decreases upon HT
- n_d of Ba₂LaF₇ crystal is 1.54
- n_d difference (Δn_d) is 0.0059, which is < 0.01

STEM and EDS Mapping

- Flower-like and tiny Ba₂LaF₇ crystals grow with HT.
- Most La³⁺, F⁻ ions, and few Ba²⁺ ions diffuse from glass phase to Ba₂LaF₇ upon HT.