

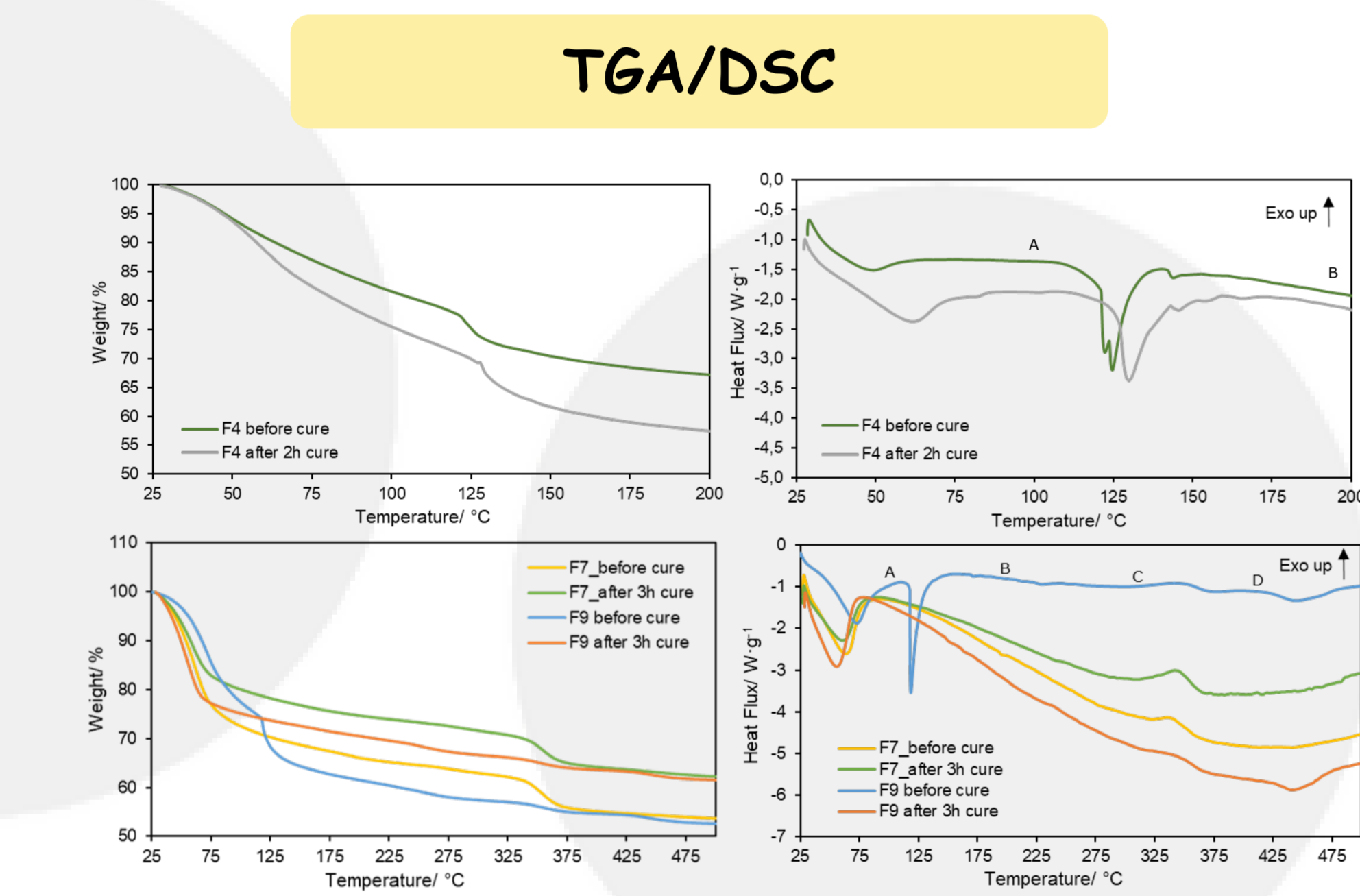
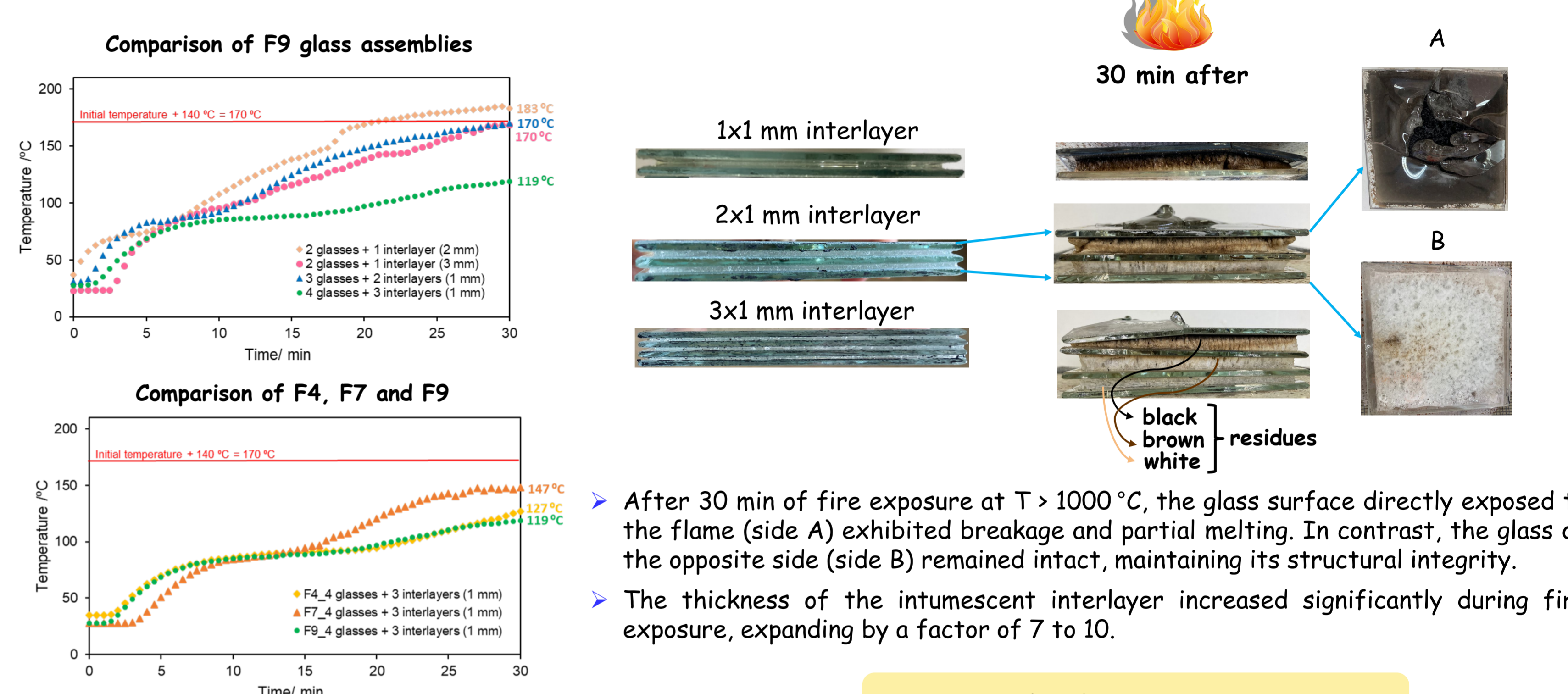
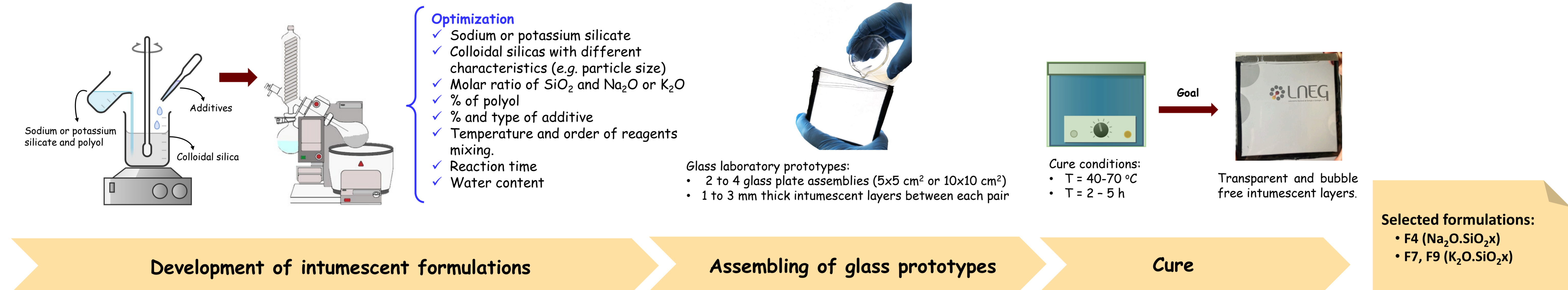
Intumescent Gels for Fire-Resistant Glass

Thermal Insulation, UV Protection, and Durability Studies

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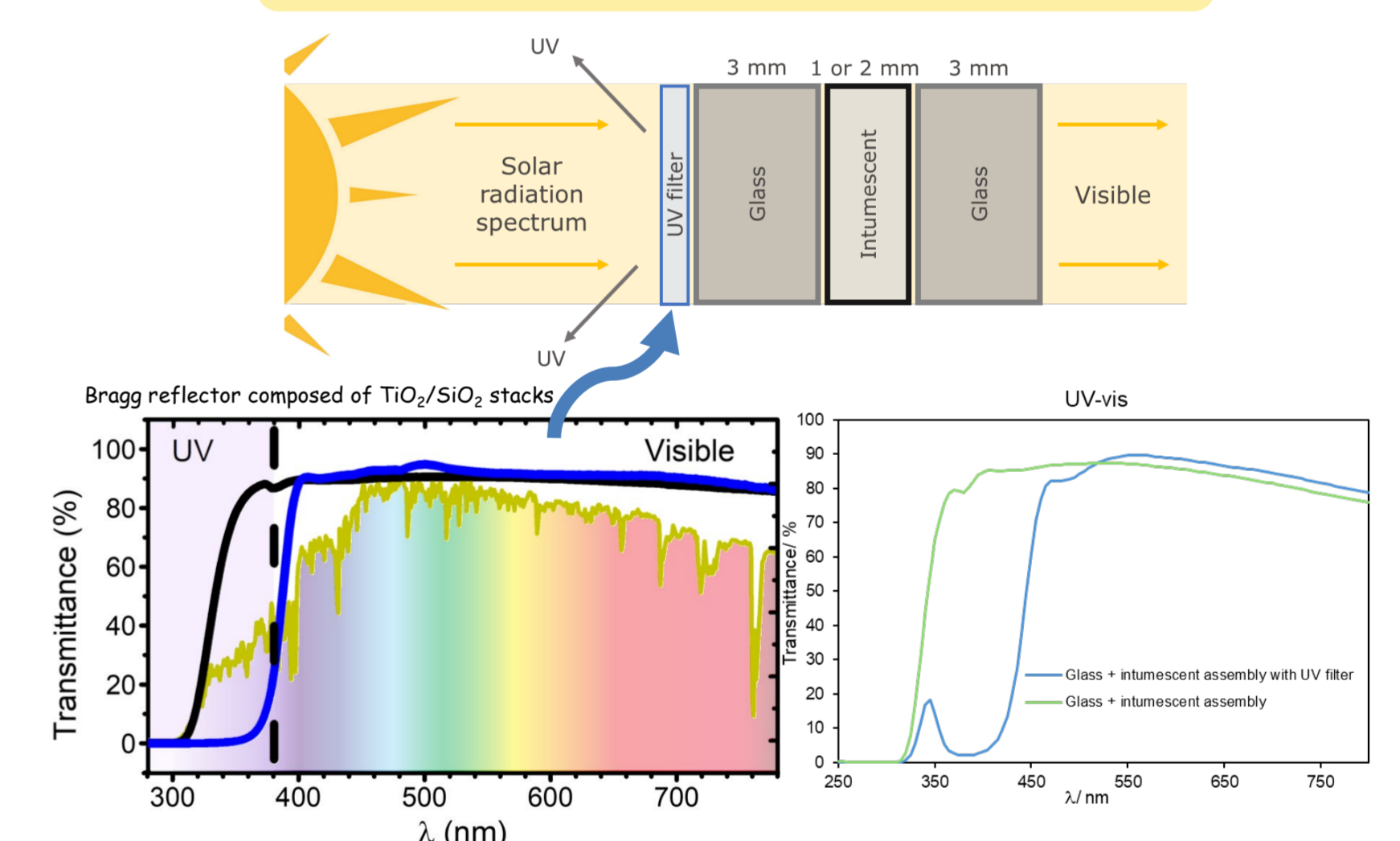
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Safety in buildings is a mandatory issue in today's construction. Fire-resistant glass is widely used in architectural elements such as partition walls, fire doors, fire windows, escape routes, and staircases due to its excellent light transmission and protective properties [1]. This study focuses on the development and characterization of an innovative intumescent material that is free from acrylamide and its derivatives, to avoid the potential toxic effects associated with these compounds [2]. The goal is to produce fire-resistant glass capable of achieving an EI 30 classification, in accordance with the EN 13501-2 standard [3]. Small-scale laboratory prototypes were assembled using two to four glass plates (5x5 cm² or 10x10 cm²), with interleaved intumescent layers ranging from 1 to 3 mm in thickness. These assemblies were tested for fire resistance to evaluate their performance. Additionally, UV protection was assessed by applying a Multilayer Bragg Reflector (MBR) coating to the outermost surface. The intumescent interlayers were also characterized both before and after fire exposure to evaluate structural and functional changes.

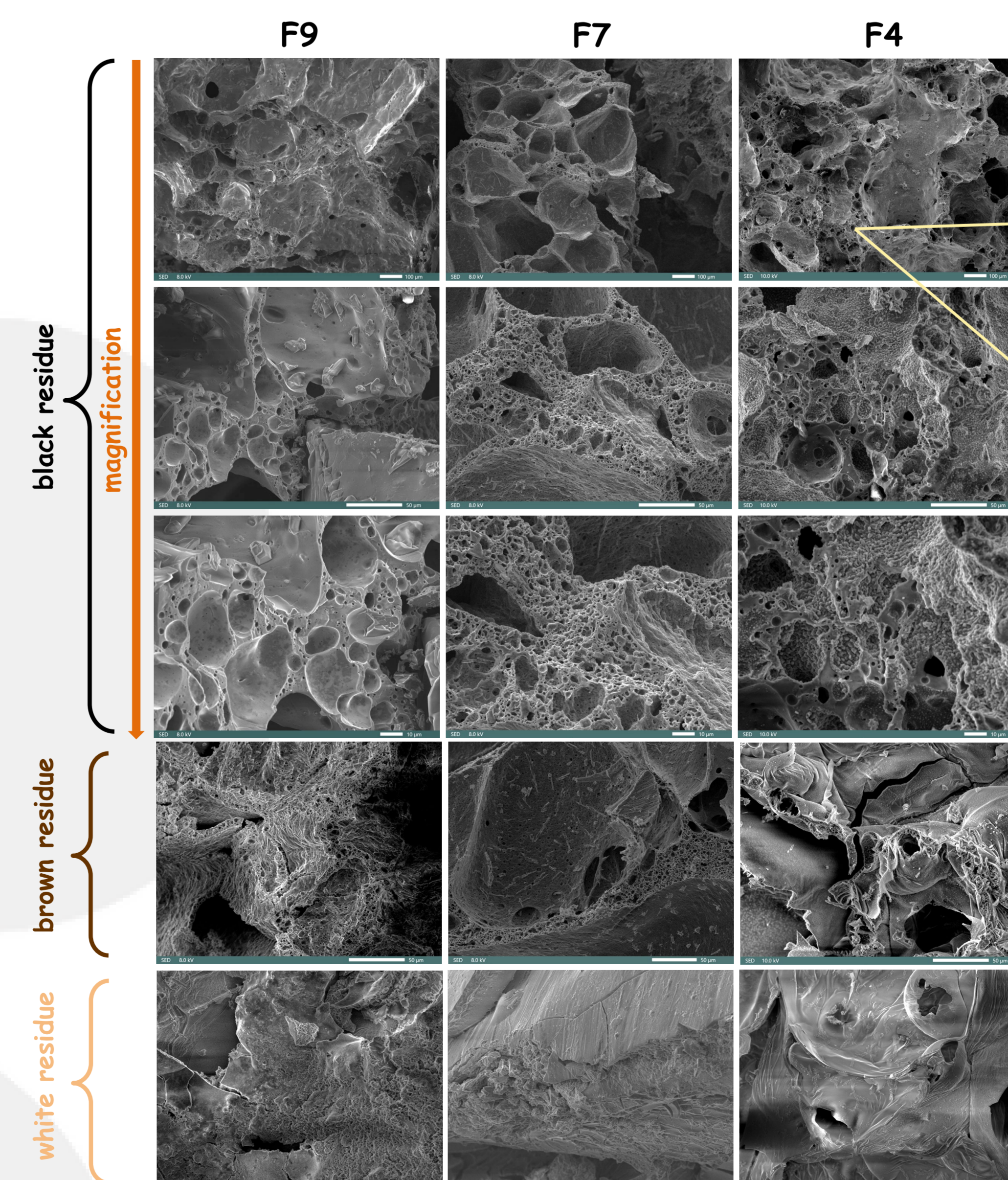


- Glass assemblies incorporating multiple 1 mm intumescent interlayers exhibit superior thermal insulation performance compared to those containing a single 2 mm or 3 mm interlayer. The most effective configuration consisted of four glass panes separated by three 1 mm interlayers.
- Among comparable types of glass assemblies, interlayers based on potassium silicate formulations (F7 and F9) demonstrated greater thermal efficiency than those based on sodium silicate (F4). All tested formulations met the normative requirements for thermal insulation performance.

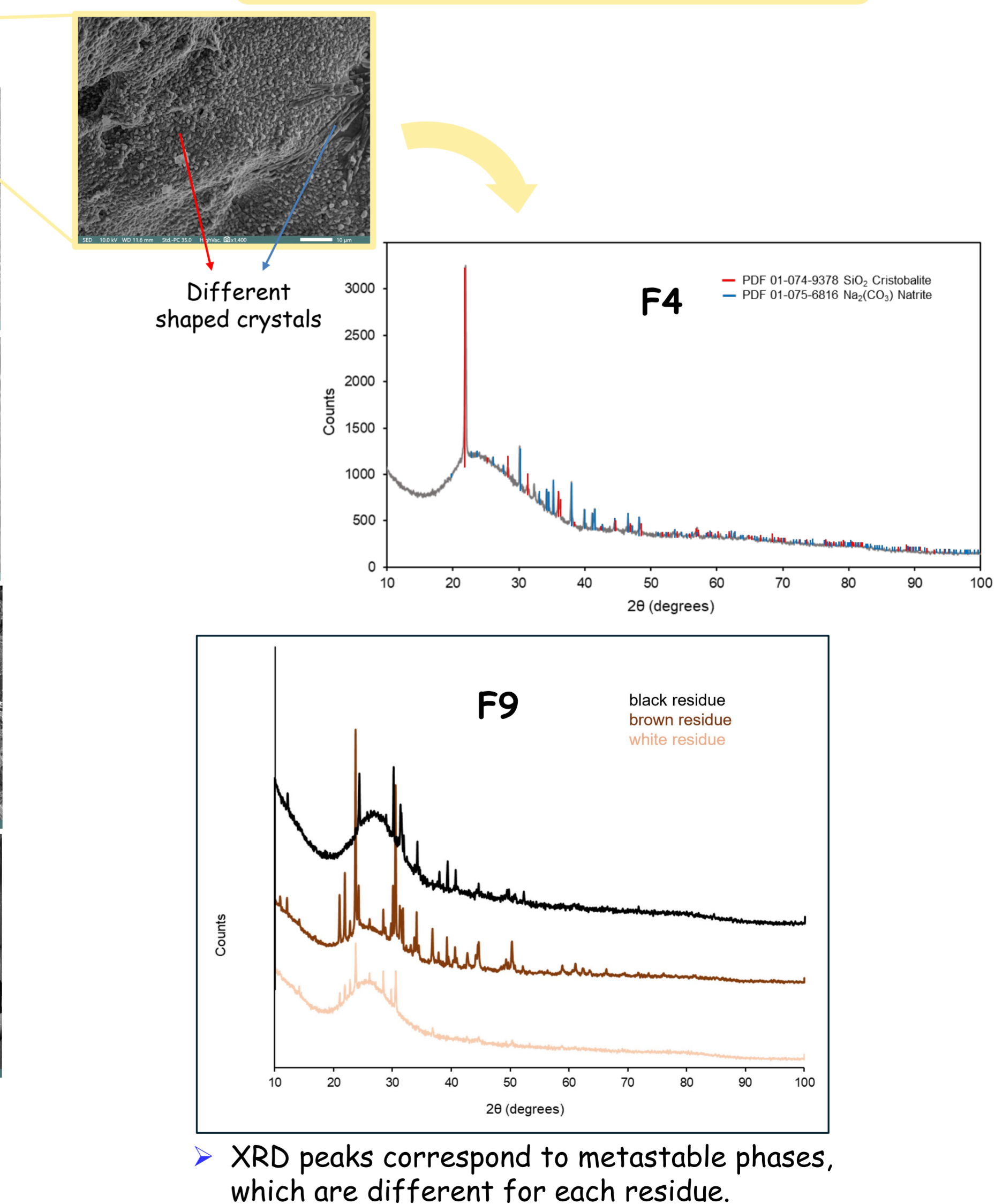
Optical Characterization



SEM



XRD



Concluding remarks

- While all tested formulations complied with the normative thermal insulation requirements, the potassium silicate formulation F9 demonstrated superior efficiency compared to F4 and F7.
- DSC/TGA confirmed the water content at various formulation stages, as well as the temperature ranges associated with the degradation of organic components.
- Preliminary durability tests of the glass assemblies indicated improved UV protection, attributed to the application of a MBR coating on the outermost surface.
- SEM micrographs revealed that the black residue of formulation F9 exhibited larger pore sizes, correlating with the greater expansion (interlayer thickness) observed after fire exposure, when compared to the residues of F4 and F7.
- XRD analysis of the F4 black residue (post-fire) revealed the presence of cristobalite (tetragonal silica) and natrite (monoclinic sodium carbonate), findings that align well with the microstructural features observed by SEM.
- Ongoing work aims to further optimize the formulations and optical filters, and to complete the comprehensive materials characterization and durability testing.

References: [1] - W. Lei, X. Ge, X. Zhou, Y. Tang, Thermal intumescent behavior of a gel containing silica, *RSC Adv.* **2015**, *5*, 33208-33211.
[2] - W. Liu, X. Ge, Z. Zhang, Study of the relationship between thermal insulation behavior and microstructure of a fire-resistant gel containing silica during heating *Fire and Materials*, **2018**, *42*, 44-49.
[3] - EN 13501-2:2023 Fire classification of construction products and building elements - Part 2: Classification using data from fire resistance and/or smoke control tests, excluding ventilation services.

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