



SnO₂ BASED GLASSES

A viable photonic system

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CSMFO LAB. CHARACTERIZATION and DEVELOPMENT of MATERIALS for PHOTONICS and OPTOELECTRONICS Laboratory



MOTIVATION

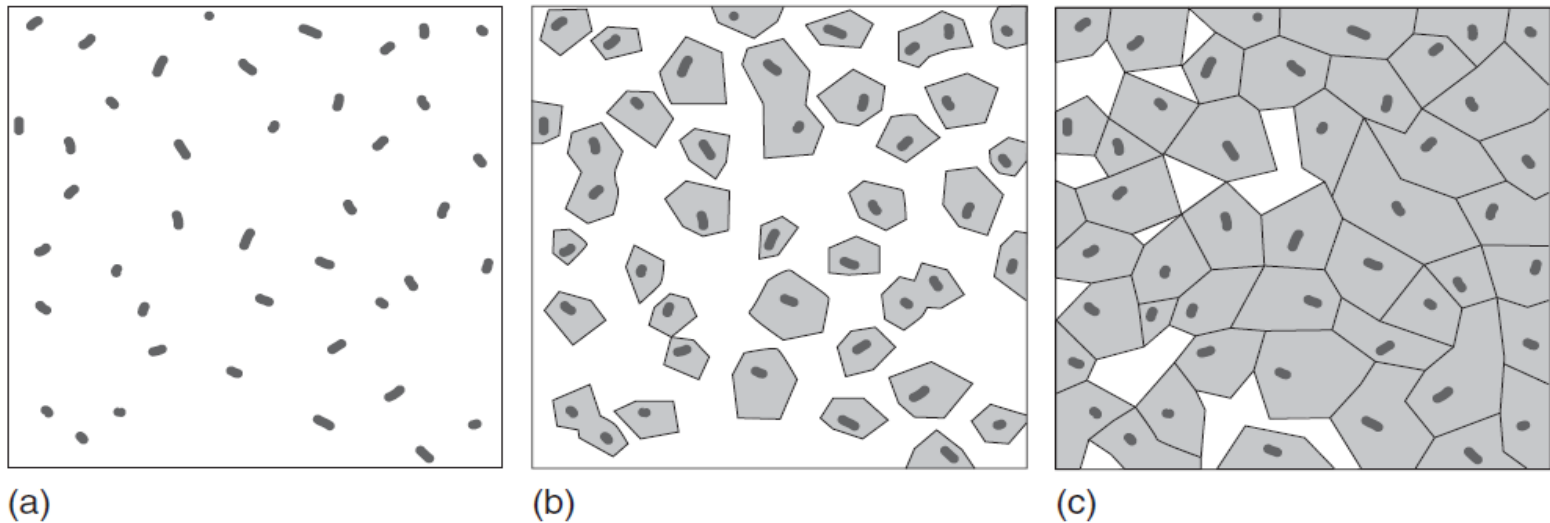
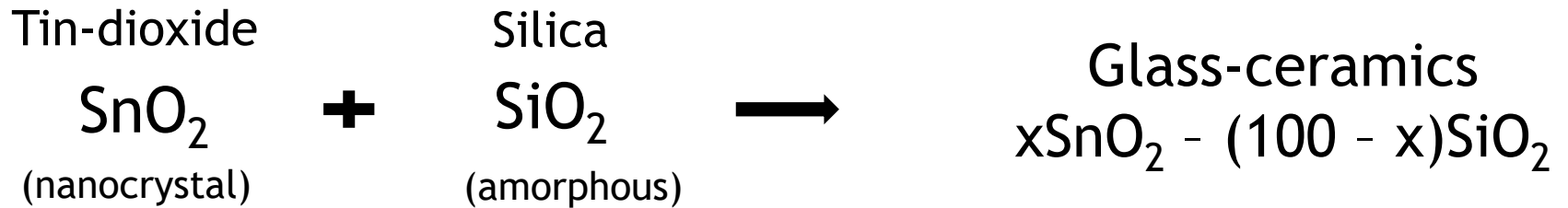
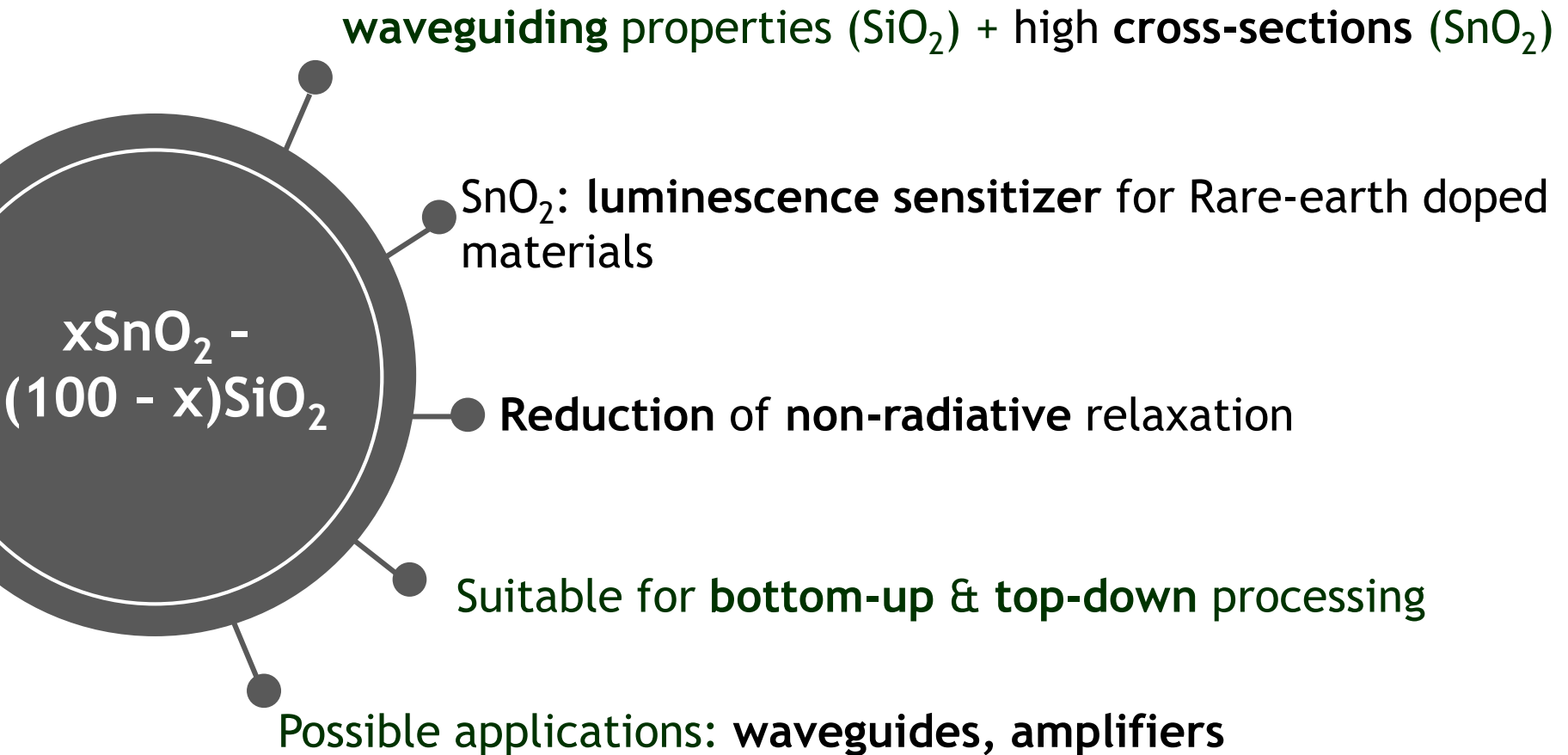


Figure H1 From glass to glass-ceramic. (a) Nuclei formation, (b) crystal growth on nuclei, and (c) glass-ceramic microstructure.

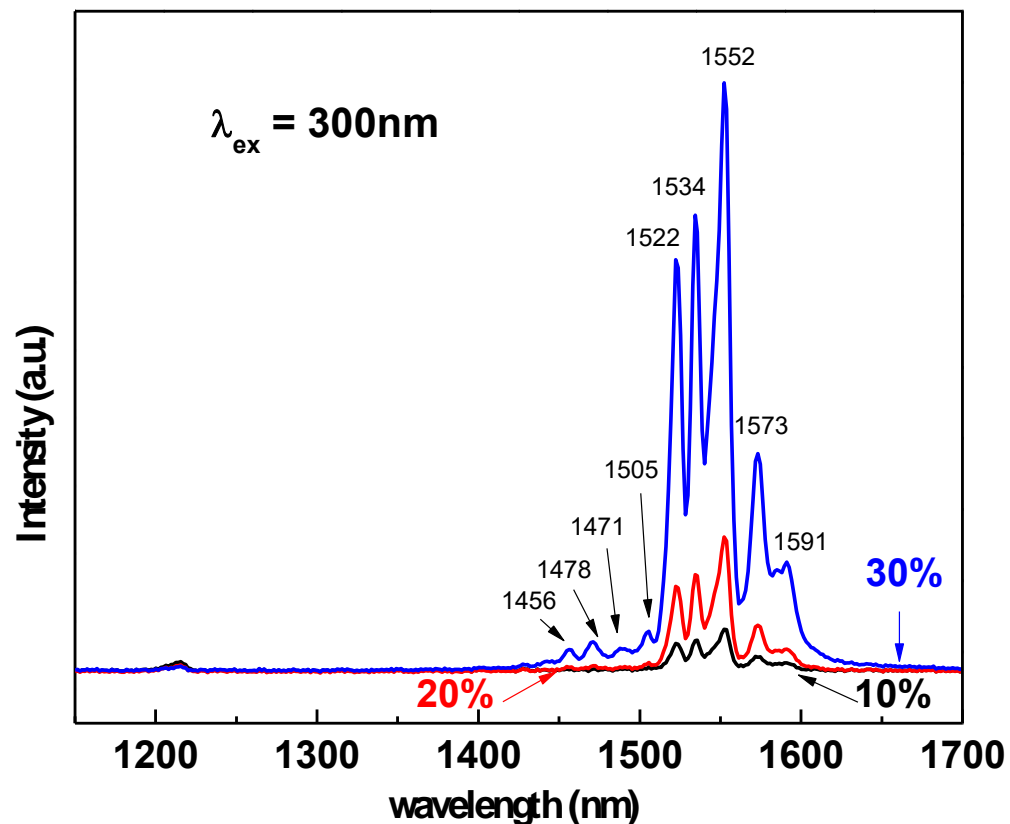
From: Glass-ceramics technology Book - George H. Beall and Wolfram Holand (2002)

Structural properties

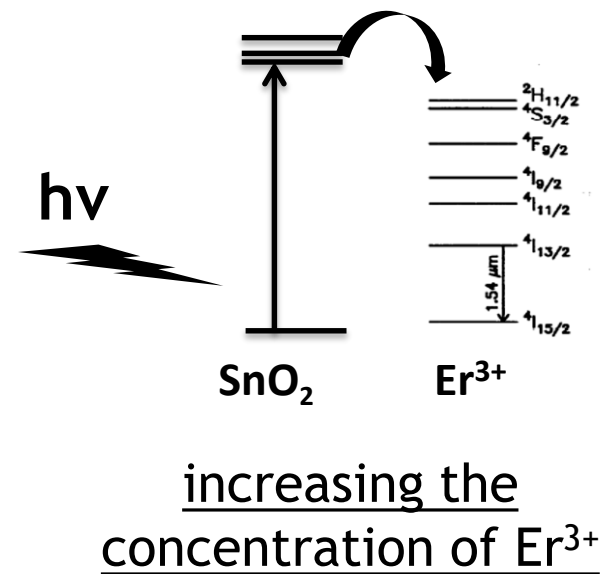
Randomly oriented grains generally without micro-cracks, or other porosity.



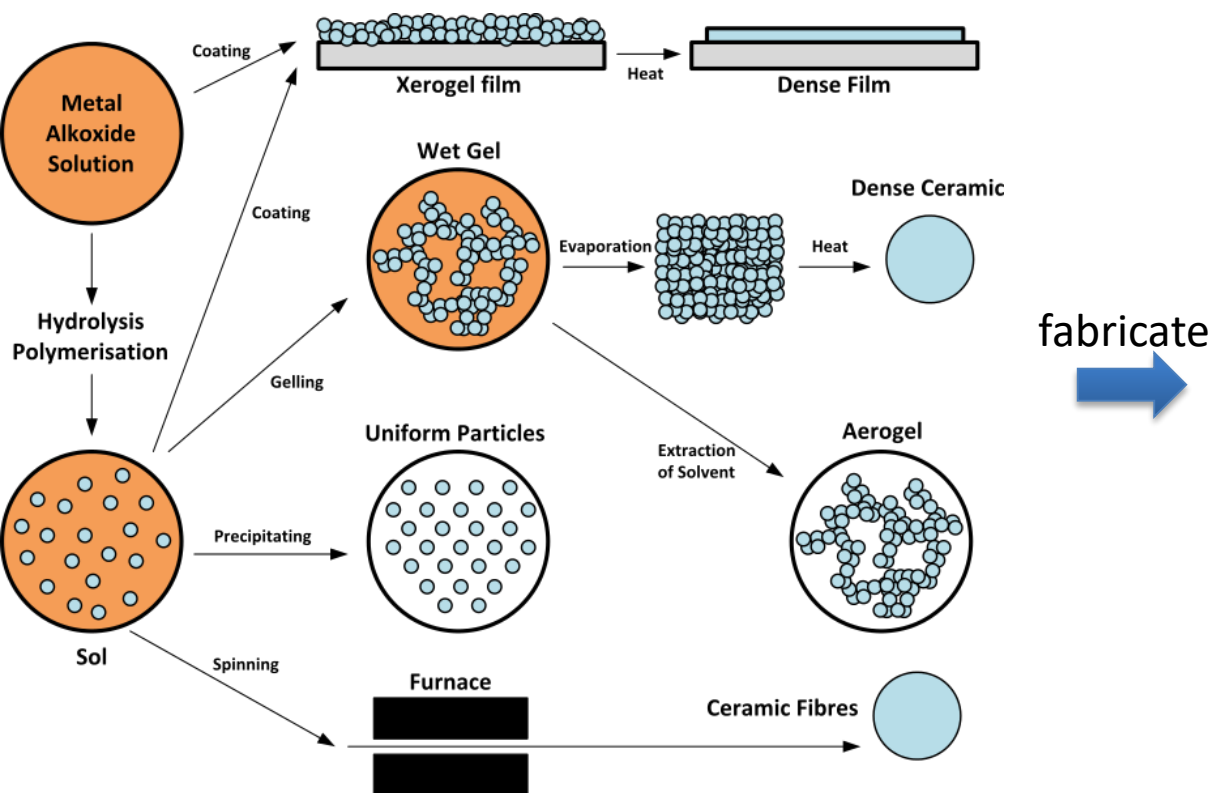
Photoluminescence



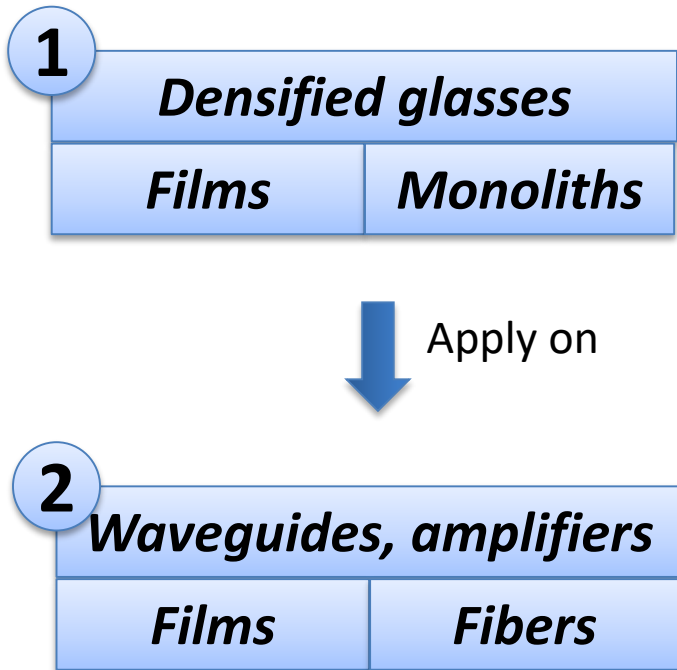
*PL spectra of $x\text{SnO}_2-(100-x)\text{SiO}_2-1\text{Er}^{3+}$
($x = 10, 20, 30 \text{ mol\%}$)*



Sol-gel processing



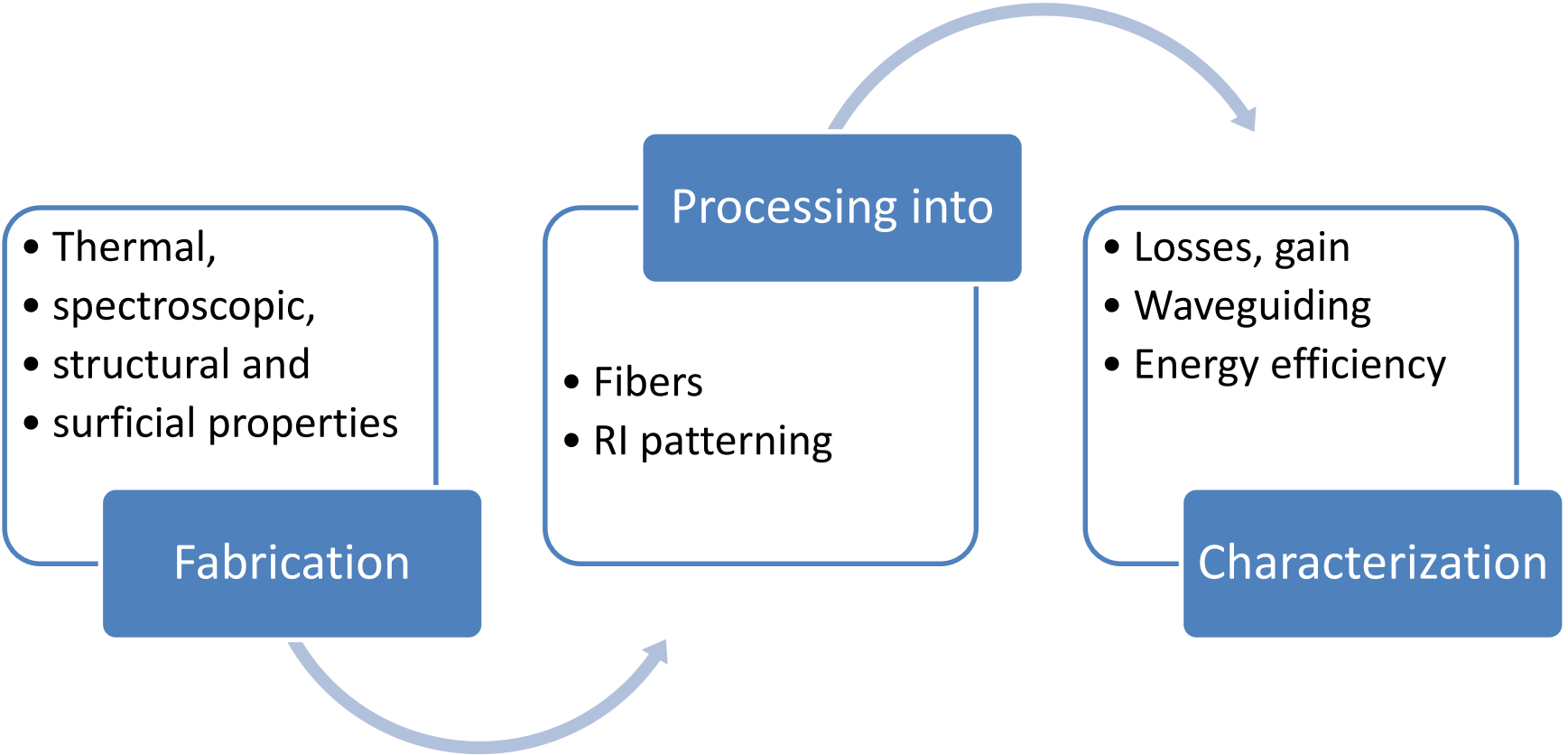
From: Sol-gel https://commons.wikimedia.org/wiki/File:Sol-Gel_Scheme.svg

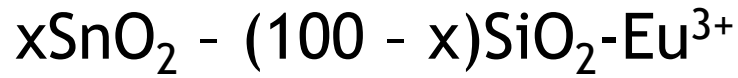


THE LITERATURE

| | Chiodini et al. | Nagomi et al. | Van et al. |
|-----------------------------------|--|------------------------------------|--|
| SnO ₂ contents | Up to 15 mol% (2002) | Up to 20 mol% (2006) | Up to 20 mol% (2012) |
| SnO ₂ nanocrystal size | 10 nm (15 mol% SnO ₂) | 4.4 nm (10 mol% SnO ₂) | ~ 5.5 nm (all SnO₂ contents) |
| Porosity | < 1 m ₂ /g after heat-treated at 750°C | --- | < 1 m ₂ /g after heat-treated at 1100°C |
| Phase change properties | Can be composed/ decomposed by thermal, X-ray radiation, UV-Vis laser irradiation, and heat-treatment condition (in air, oxygen, H ₂) | | |
| Optical properties | <ul style="list-style-type: none"> • UV-Vis photorefractivity ($\Delta n \sim 10^{-4}$) • Third order and cubic nonlinearity • Refractive patterning by femtosecond laser irradiation | | |
| Doped with RE ions | <ul style="list-style-type: none"> • SnO₂ crystals transfer energy into RE ions. So, the luminescence intensity increases depend on SnO₂ crystal size. • Lifetime: 4-10 ms, depending on SnO₂ & RE dopant contents. • Dopants: Er³⁺, Eu³⁺, Tb³⁺, Sm³⁺, and codoped Eu³⁺ and Tb³⁺ | | |

RESEARCH PLAN





Samples status

| Composition | | | | | |
|----------------------|---|--|--|---|--|
| Sample 1 | Sample 2 | Sample 3 | Sample 4 | Sample 5 | Sample 6 |
| 100%SiO ₂ | 95%SiO ₂ - 5%SnO ₂ - | 90%SiO ₂ - 10%SnO ₂ - | 100%SiO ₂ - 1%Eu ³⁺ | 95%SiO ₂ - 5%SnO ₂ - 1%Eu ³⁺ | 90%SiO ₂ - 10%SnO ₂ - 1%Eu ³⁺ |

Shape



cube



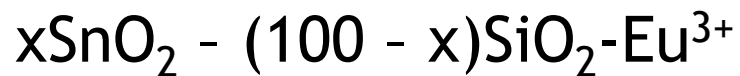
pillar



dish

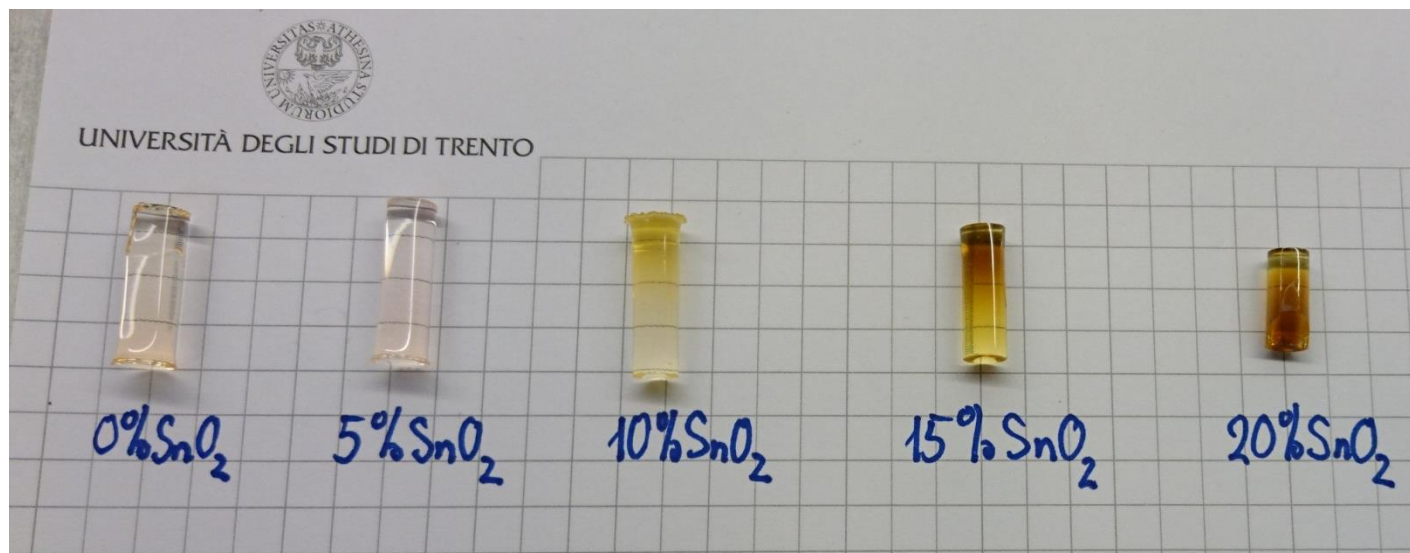
Heat-treatment

- Initial heat-treatment: at 40 °C for first 3 days and at 70 °C for the next 4 days
 - Lack of final heat-treatment



Samples status

| Composition | | | | |
|--|---|--|--|--|
| Sample 1 | Sample 2 | Sample 3 | Sample 4 | Sample 5 |
| 100%SiO ₂ - 0.5%Er ³⁺ | 95%SiO ₂ - 5%SnO ₂ - 0.5%Er ³⁺ | 90%SiO ₂ - 10%SnO ₂ - 0.5%Er ³⁺ | 85%SiO ₂ - 15%SnO ₂ - 0.5%Er ³⁺ | 80%SiO ₂ - 20%SnO ₂ - 0.5%Er ³⁺ |



THANK YOU