Growth of borate-based crystals for UV laser generation by the micro-pulling down technique
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**Final goal**
- studying suitable materials for frequency conversion in the blue-UV range
- growth of good optical quality fiber crystals by the micro-pulling-down technique (μ-PD)

**Interest of crystalline fibers**:
- aspect ratio and heat dissipation

**Materials : borates**

<table>
<thead>
<tr>
<th>Property</th>
<th>BZBO</th>
<th>LBGO (LBGO)</th>
<th>BCBF (LBGO)</th>
<th>Cn(BO3)F (CBF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hygrosopicity</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Congruent melting</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>SNR efficiency for l=1064 (m)</td>
<td>four times KDP (type-I phase-matching)</td>
<td>one-two times KDP (type-I phase-matching)</td>
<td>two times KDP (type-II phase-matching)</td>
<td></td>
</tr>
<tr>
<td>UV absorption edge</td>
<td>350 nm</td>
<td>190 nm</td>
<td>190 nm</td>
<td>196 nm</td>
</tr>
<tr>
<td>Optical axes</td>
<td>positive, biaxial</td>
<td>positive, uniaxial</td>
<td>negative, uniaxial</td>
<td>negative, biaxial</td>
</tr>
</tbody>
</table>

**BiZn₂B₂O₇ : BZBO**
- Transparent and uniformly colored fiber (yellow-red) without cracks and bubbles
- SEM characterization
- Bi-rich small clear parts of different shapes dispersed in a darker matrix
- Elementary analysis of BZBO crushed fibers
  - B₁₂₋₃Zn₁₂₋₃O₃₅₄
- Evaporation of B₂O₃ (13.5%)
- Incongruent behavior of the melt (peritectic type?)
- Growth with low pulling rate : 0.15 mm.h⁻¹
- Colorless crystal

**LaBGeO₅ : LBGO**
- Hand made Pt crucible
- Too high viscosity
- Flux growth required
- Several fluxes tested:
  - LIF
  - LIF+B₂O₃
- LIF flux
  - Failure of growth attempts due to:
    - still too high viscosity
    - strong LIF evaporation
  - Example of fibers
  - Polycrystalline fiber
  - Raman spectroscopy shows the presence of an unidentified phase

**BaCaBO₃F : BCBF**
- BCBF fiber and SEM characterization of fibers obtained
- V = 12 mm.h⁻¹
  - Black, opaque fiber
- V = 4.2 mm.h⁻¹
  - Colored, quasi transparent fiber
- V = 2.4 mm.h⁻¹
  - Colored, opaque fiber
- Presence of different phases and cracks
- EDS characterization: presence of Pt and Rh

**Crystals growth by μ-PD**
- Homogeneous composition crystal
- High crystal quality
- Little feed material
- High pulling rate (up to 12 mm/h)
- Fiber diameter : 50 µm to several mm
- Interest of μ-PD:

**Conclusion**
Growth of borate-based crystals by μ-PD : not an easy task !
- BZBO: growth of transparent and colorless crystals possible with a very low pulling rate.
- CBF: growth conditions well defined. Good quality crystal fibers obtained
- BCBF: growth impossible by μ-PD
- LBGO: LiF-B₂O₃ flux needs to be improved and optimized to hope obtaining single-crystal fibers