Result of a Correlation Study

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54 PWO samples were studied at Caltech: 32 from SIC (20 of 2002 batches and 12 of 2004 batches) and 21 from BTCP (19 of 2001 batches and 2 of 2003 batches).

Correlations between the slope of crystals’ initial longitudinal transmittance around the band edge and its radiation damage, i.e. the relative light output loss under 15 rad/h irradiations and the emission weighted radiation induced absorption coefficient (EWRIAC), were investigated for all samples.
Transmittance Measurement

HITACHI U-3210 UV/VIS spectrophotometer with double beam, double monochromator & a large sample compartment

Beam 1

Beam 2

\[ T_s = (1 - R)^2 + R^2 (1 - R)^2 + \ldots = \frac{1 - R}{1 + R}, \quad \text{with} \]

\[ R = \frac{(n_{\text{crystal}} - n_{\text{air}})^2}{(n_{\text{crystal}} + n_{\text{air}})^2}. \]

Precision: 0.3%

Theoretical limit of transmittance: NIM A333 (1993) 422
Fit Slope for the Initial LT Data

Fit region: 350 -- 370 nm for BTCP samples (“a” axis)
352 -- 372 nm for SIC samples (“c” axis)

BTCP-2375

- 200°C annealing
- fit

slope: 2.62 %/nm

SIC-570

- 200°C annealing
- fit

slope: 2.43 %/nm
Slope Fits for BTCP and SIC Samples

20 BTCP Samples

30 SIC Samples

Transmittance (%)

Wavelength (nm)

Transmittance (%)

Wavelength (nm)
δLO/LO @ 15 rad/h versus Slope

**No correlation:** Slope of initial LT is not correlated to the light output loss.

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**BTCP - PWO**
- Circle: 2001
- Dot: 2003
- After 15 rad/h in Equilibrium
- CC = -0.199

**SIC - PWO**
- Circle: 2002
- Dot: 2004
- After 15 rad/h in Equilibrium
- CC = 0.278

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Initial L.T. Slope 350-370 nm (T%/nm) vs. Light Output Loss (%)

Initial L.T. Slope 352-372 nm (T%/nm) vs. Light Output Loss (%)
EWRIAC @ 15 rad/h versus Slope

**No correlation:** Slope of initial LT is not correlated to the radiation induced absorption

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**EWRIAC @ 15 rad/h versus Slope**

**BTCP - PWO**
- Circle: 2001
- Dot: 2003
- After 15 rad/h in Equilibrium
- CC = -0.139

**SIC - PWO**
- Circle: 2002
- Dot: 2004
- After 15 rad/h in Equilibrium
- CC = -0.076

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Initial L.T. Slope 350-370 nm (T%/nm)  
Initial L.T. Slope 352-372 nm (T%/nm)
EWRIAC @ 400 rad/h versus Slope

**No correlation:** Slope of initial LT is not correlated to the radiation induced absorption

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**BTCP - PWO**
- Circle: 2001
- Dot: 2003
- After 400 rad/h in Equilibrium
- CC = 0.055

**SIC - PWO**
- Circle: 2002
- Dot: 2004
- After 400 rad/h in Equilibrium
- CC = 0.195
EWRIAC @ 9 krad/h versus Slope

**No correlation:** Slope of initial LT is not correlated to the radiation induced absorption

**Diagrams:**
- **BTCP - PWO**
  - After 9000 rad/h in Equilibrium
  - CC = -0.238
  - Circle: 2001
  - Dot: 2003

- **SIC - PWO**
  - After 9000 rad/h in Equilibrium
  - CC = 0.198
  - Circle: 2002
  - Dot: 2004
δLO/LO versus Initial LT and EWRIAC

No correlation between δLO/LO and Initial LT
Weak (0.48) correlation between δLO/LO and EWRIAC
EWRIAC versus Initial LT

No correlation: preexisting absorption is not correlated with radiation induced absorption
Summary

- No correlations were found between the slope of crystals’ initial longitudinal transmittance around the band edge and its radiation hardness for both BTCP and SIC samples.

- This result consists with the Rome group observation reported in the June 21, 2005, DPG meeting: 3/5 BAD Xtals with slope OK and 4/5 OK Xtals with slope BAD, indicating that slope at the band edge is not reliable.

- Recalling our previous result of no correlations between the initial LT and radiation hardness reported in the November 3, 2005, DPG meeting, it seems necessary to irradiate and sort endcap PWO crystals before installation.
Emission Weighted RIAC

All samples: EWRIAC < 1 m\(^{-1}\) up to 400 rad/h
Rigorous QC required to qualify endcap crystals for SLHC