STATUS on PWO crystals from Bogoroditsk for CMS-ECAL

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History

- 1992 Crystal2000: 1st interest on PWO
- 1994: choice of PWO for CMS-ECAL

- 1998-2000: Preproduction of 6000 crystals
  - Increase the rate of production
  - Reach an uniformity in quality of crystals
- 2001: Start of the Production
Main Result on RD Phase

Radiation damage mainly due to Host structure defects:

Primary defects:
- Lead vacancy $V_k$(Pb)
- Oxygen vacancy $V$(O)

Secondary defects created for charge compensation:
- for $V_k$(Pb): $O^{-} + h$, Pb$^{2+} + h$
- for $V$(O): F and F$^{+}$ centres

Optimisation of:
- growth conditions
- stoechiometry

Compensation by doping:
- Y, Nb

R&D on Radiation hardness of full size russian crystals
Goal of Pre-Production Phase

For Producer:
- Increase the rate of production
- Improve the crystal quality and homogeneity of properties

For CMS-ECAL community
- Setting up the Regional centres
- Installation of Automatic Crystal Control System (ACCOS)
  Machine designed to make the full characterisation of 30 crystals in 7 hours

All the 6000 crystals have been measured on ACCOS at CERN
Quality Control

- Lamp
- Photodetector
- Light yield uniformity
- Transmission
- Dimensions
- ACCOCE
420nm Optical Transmission

**Batch 1**
- **11/100 rejected**

**Batch 8**
- **0/500 rejected**

**Batch 14**
- **0/500 rejected**
Light Yield

Batch 1 to 7 \(<\text{Ra}\>\) depolished face +0.2%

Batch 8 to 14 \(<\text{Ra}\>\) depolished face +0.39%
Radiation Hardness

Front irrad., 1.5Gy, 0.15Gy/h

Low dose rate irradiation of some BTCP crystals of Batch06 in lab27

Statistic on 337 crystals
Mean Value : 2.46 %
Standard deviation 1.07%
Radiation Hardness

Front irrad., 1.5Gy, 0.15Gy/h

Batch1

Statistic on 32 crystals
Mean Value : 3.39%
Standard deviation 1.21%

Batch8

Statistic on 33 crystals
Mean Value : 1.92%
Standard deviation : 0.90%

Batch14

Statistic on 366 crystals
Mean Value : 2.45 %
Standard deviation 1.06%
Pre-Production Phase

From Sept 98 to Dec 2000 6000 Crystals produced by BTCP

Success to increase:
The yield
The production rate

Improvement and Homegenisation of crystal quality
Since beginning 2001: Production phase

It remains to be produced before end 2004:
- 56000 crystals for Barrel
- 16000 crystals for Endcaps

Today we have:
- 6000 preproduction crystals
- 2000 production crystals

Need to increase productivity

New crystal development:
Ingot diameter increase
65mm diameter PWO ingots from Bogoroditsk
Technology steps

1996
Barrel
32 mm

1999
Endcap
44 mm

End 2000
Barrel
65 mm
Batch P2 from CERN/ISTC production contract #1718 was used to compare:

- 260 barrel crystals produced with the standard technology
- 40 barrel crystals produced with the new technology

**T360**

300 crystals measured:
- Mean value: 31.36%
- Standard dev.: 3.3%

**T420**

300 crystals measured:
- Mean value: 69.91%
- Standard dev.: 0.85%
Batch P2 from CERN/ISTC production contract #1718 was used to compare:

- 260 barrel crystals produced with the standard technology
- 40 barrel crystals produced with the new technology

Statistic on 300 crystals
Mean Value: 3.30%/nm
Standard Dev: 0.06%/nm

Statistic on 300 crystals
Mean value: 9.1 pe/MeV
Standard deviation: 0.57 pe/MeV
Batch P2 from CERN/ISTC production contract #1718 was used to compare:

- 260 barrel crystals produced with the standard technology
- 40 barrel crystals produced with the new technology

Low dose rate irradiation of some crystals from BatchP2-1

Front irrad., 1.5Gy, 0.15Gy/h
Radiation damage

PWO 7365 1st irradiation at the hospital (430 Gy)

- 1i1
- 1ir1
- Irr1 + 20'
- Irr1 + 40'
- Irr1 + 24h

transmission (%) vs. Wavelength (nm)
Conclusions

- Success of the R&D phase
  - Increase of the production rate
  - Good quality crystals
  - Uniform optical properties

- Technology for ingots up to 65mm diameter is now well under control

- The possibility to further increase the diameter and to apply this approach to endcap crystals is demonstrated
Conclusions

Ready to construct the CMS-ECAL

1st module of 400 crystals build in 2001 for ECAL