Long Term Recovery of PWO Crystals

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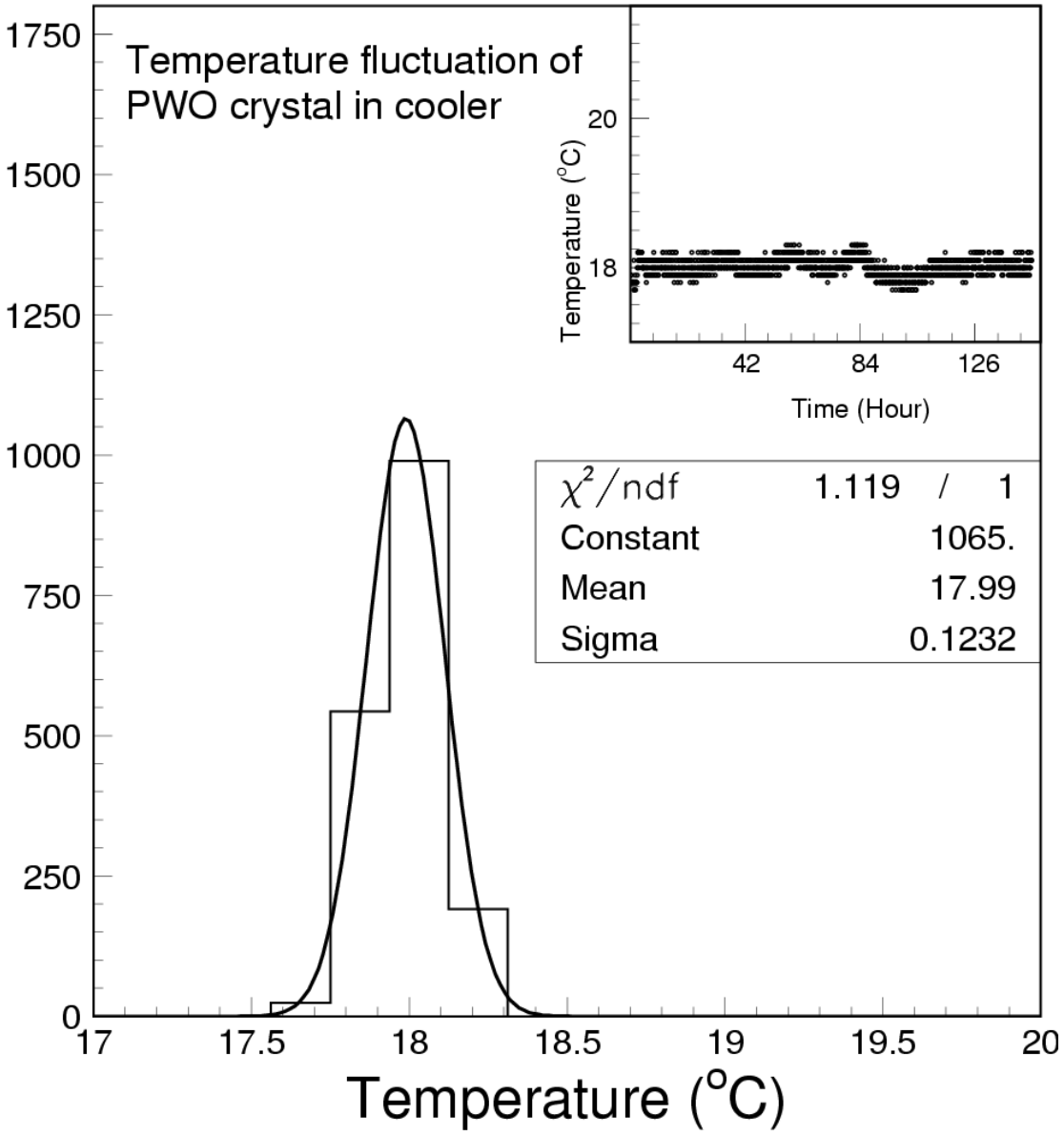
Introduction

- Two endcap size PWO samples from the SIC May batch (#2630 and 2641) went through standard procedure: (1) thermal annealing at 200^{o}C, (2) irradiations by γ–ray at 15, 400 and 9k rad/h until equilibrium and (3) recovery after 9 krad/h at 18^{o}C. See report in September DPG meeting for an overall comparison with 20 CEBAF size SIC 2002 samples.
- An update of long term recovery for May samples is given in this report and is compared to three samples from SIC 2002 batch and 7 samples from BTCP 2001 batch.

Long Term Recovery under 18°C



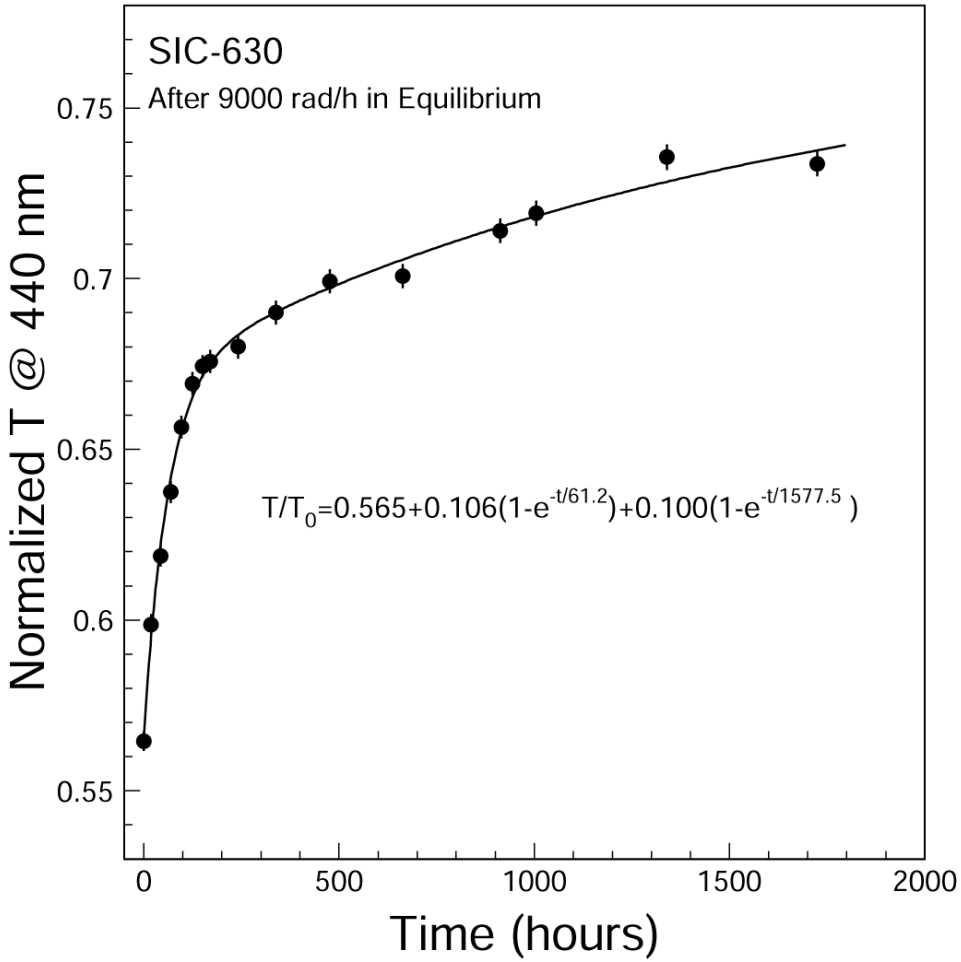
After irradiation under 9 krad/h recovery was measured when samples were kept in a cooler at 18°C with 0.12°C variation.

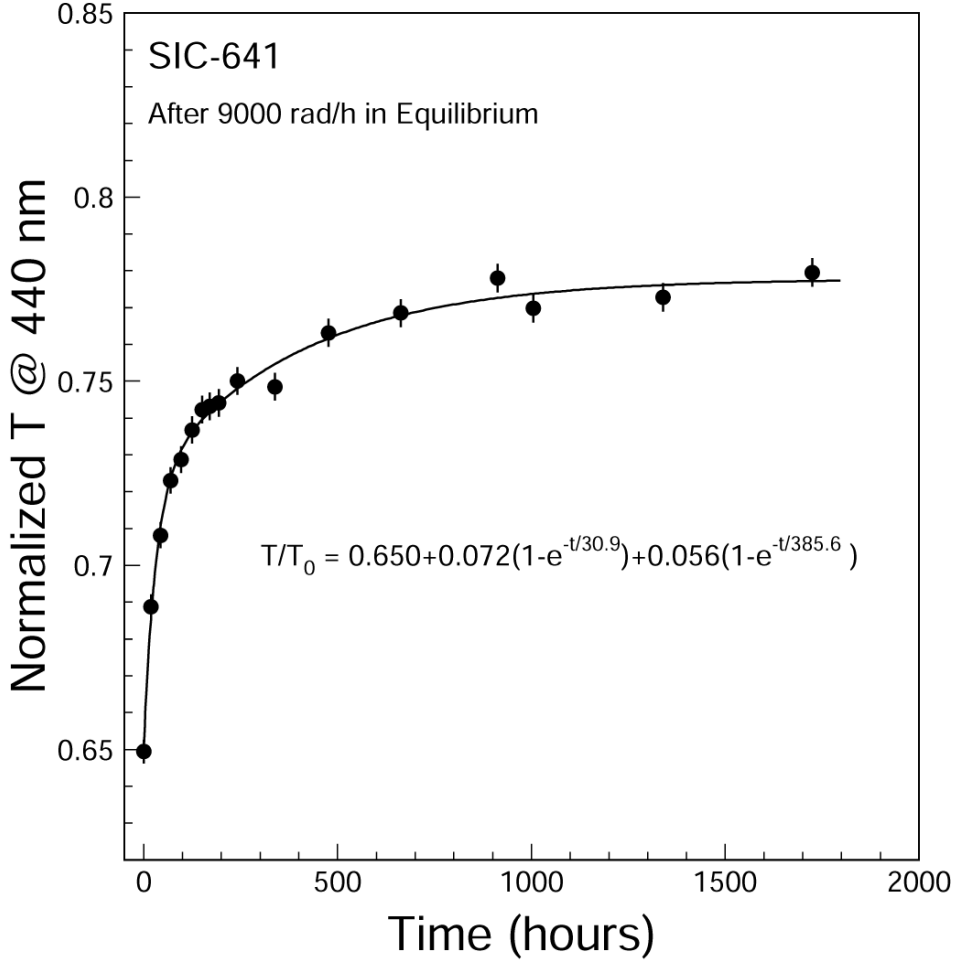
Long Term Recovery (May 2004 Batch)

Fast: 24 and 20% with time constant of 61 and 31 h

Slow: 23 and 16% with time constant of 1578 and 386 h

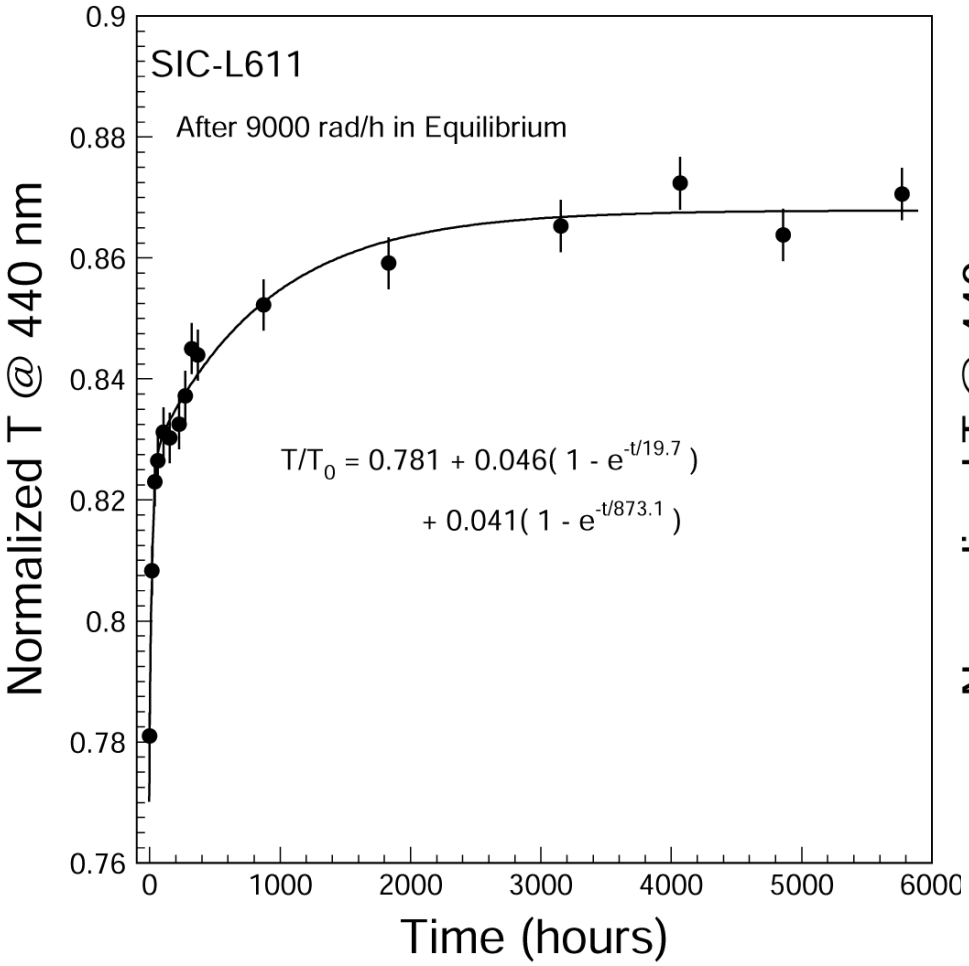
More data points are needed to constrain time components

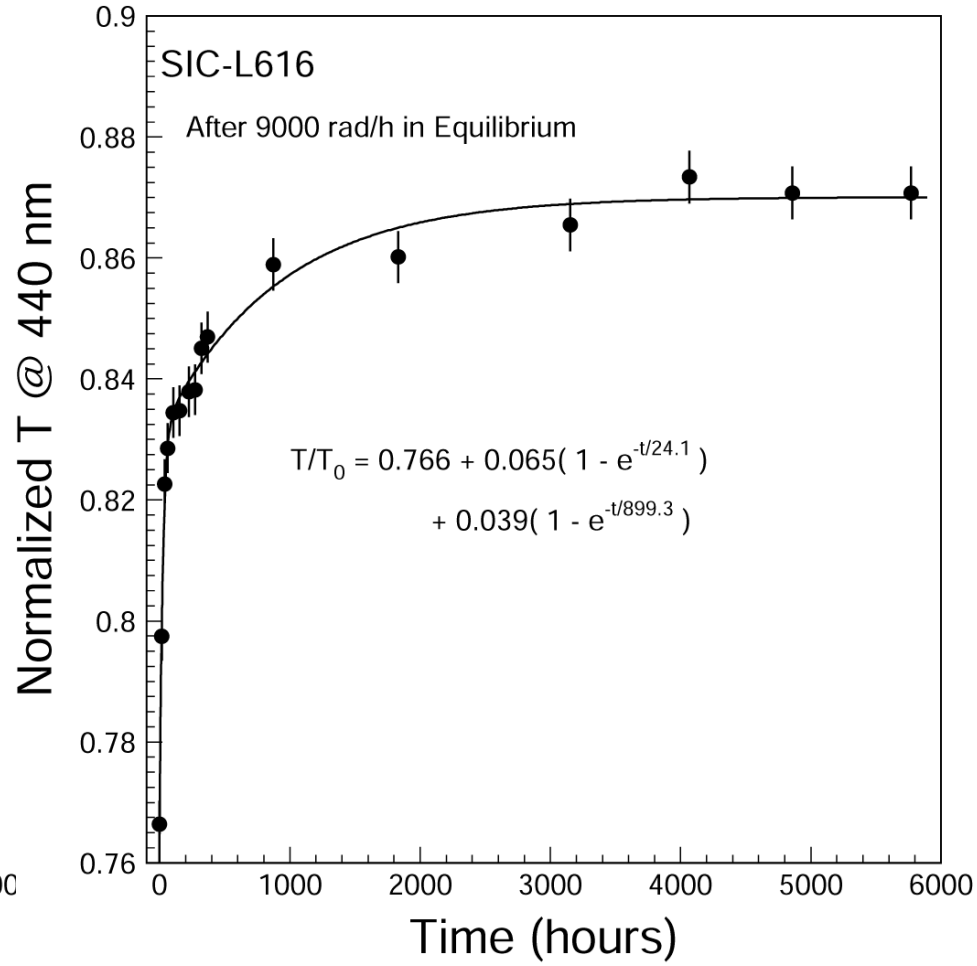




Long Term Recovery (2002 SIC Batch)

Fast: 21 and 28% with time constant of 20 and 24 h
Slow: 19 and 17% with time constant of 873 and 899 h





SIC PWO Long Term Recovery

$$\frac{T}{T_0} = A_0 + A_1(1-e^{-t/\tau 1}) + A_2(1-e^{-t/\tau 2})$$

Sample ID	1-A_0 (%)	F_1 (%)	τ_1 (hour)	F_2 (%)	τ_2 (hour)	F_∞ (%)
SIC PWO Samples, 2003 batch						
L620	15.6	32.7	26.4	14.7	1,075	52.6
L616	23.4	27.8	24.1	16.7	899	55.5
L611	21.9	21.0	19.7	18.7	873	60.3
Average	20.3	27.2	23.4	16.7	949	56.1
SIC PWO Samples, 2004 May contaminated batch						
S641	35.0	20.6	30.9	16.0	385.6	63.4
S630	43.5	24.4	61.2	23.0	1,578	52.6
Average	39.3	22.5	46.1	19.5	982	58.0

Three components in two batches:

- fast: 27& 23% of damage with time constant 23 & 46 h.
- slow: 17 & 20% of damage with time constant 949 & 982 h.
- residual (permanent): 56 or 58% damage not recovered.

Twice damage in the 2004 May batch as compared to the 2002 batch.

BTCP PWO Long Term Recovery

Reported in the DPG meeting on July 8, 2003

$$\frac{T}{T_0} = A_0 + A_1(1-e^{-t/\tau 1}) + A_2(1-e^{-t/\tau 2})$$

Sample ID	1-A_0 (%)	F_1 (%)	τ_1 (hour)	F_2 (%)	τ_2 (hour)	F_∞ (%)
Type II PWO Samples						
B2375	33.9	39.8	31.7	22.4	1,363	37.8
B2376	35.5	42.3	30.5	23.7	1,232	34.0
Average	34.7	41.1	31.1	23.1	1,298	35.9
Type I PWO Samples						
P7467	7.0	48.6	59.9	22.9	1,847	28.5
P7557	6.7	49.3	52.0	37.3	1,897	13.2
P7566	6.1	54.1	37.5	39.3	1,926	6.6
P7654	8.5	35.3	37.1	29.4	2,081	35.3
P7903	6.5	46.2	32.6	32.3	1,928	21.5
Average	7.0	46.7	43.8	32.2	1,937	21.1

F_i denotes the fraction of corresponding component.

Also three components in Type II or I:

- fast: 41& 47% of damage with time constant 31 & 44 h.
- slow: 23 & 32% of damage with time constant 1,300 & 1,900 h.
- residual (permanent): 36 & 21% damage not recovered after 4,000 h.

Summary

- The recovery characteristics of PWO crystals is rather diverse.
- Comparing with the BTCP samples (45%), the SIC samples have a smaller fraction of fast recovery (20 to 50h time constant) component (25%).
- Comparing with the BTCP samples (25%), the SIC samples have a smaller fraction of long term recovery (1000 to 2000 h) component (18%).
- Comparing with the BTCP samples (23%), the SIC samples have a larger fraction of residual damage (56%), which can be eliminated by 200^{o}C annealing.
- Excluding residual damage, SIC samples have a smaller damage amplitude.
- Additional studied needed to understand these differences.