LIGO-T040159-00-D

SF2 Glass Information 11-Aug-04

Two ½”dia. Fused Silica and SF2 substrates have been bonded using hydroxide-catalyzed surface hydration/dehydration.

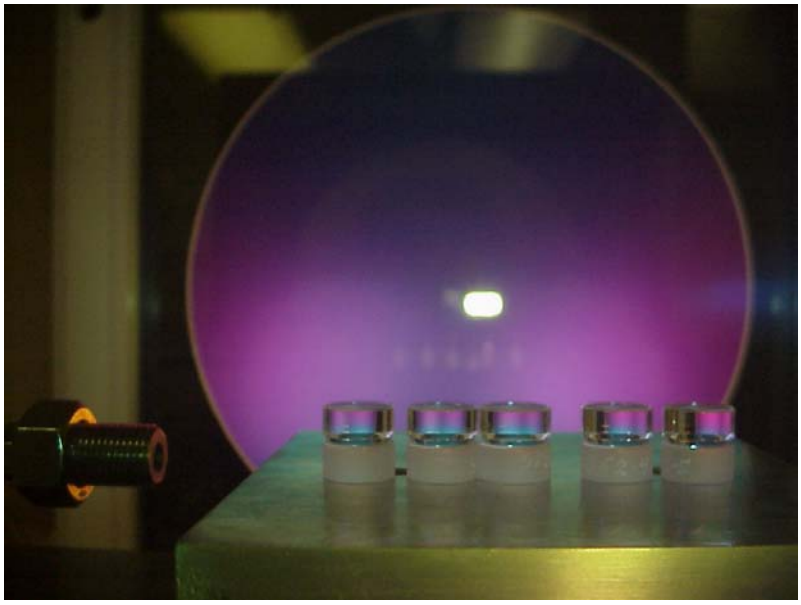
A brief series of experiments was conducted to evaluate temperature effects on SF2 glass.

SF2 glass will be used for the penultimate and reaction masses in case that sapphire is the chosen material for Advanced LIGO ITM’s and ETM’s.

Bonding of SF2 to Fused Silica

Temperature effects

Before bake, no stress is present at the bond interface when the parts are looked through a polariscope



When the bonded substrates are baked at ~32° C for three hours, a fine blue line is observed at the bond interface. (Stress is present)

After baking at ~42° C for 1 hour, the stress increases, a more prominent blue line is observed.

NOTE: When the heat source is removed, stress completely disappears after 1-2 minutes.

Following are the MSDS and the technical information for SF2 glass.

SCHOTT

MATERIAL SAFETY DATA SHEET

SECTION 1 CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name:	**SF-2**
Chemical Name:	Inorganic glass
C.A.S. Number:	65997-17-3

Schott Glass Technologies
400 York Avenue
Duryea, PA 18642

(570) 457-7485

Effective Date:	02/21/2001	Supersedes:	NA	Print Date:	02/21/2001

SECTION 2 COMPOSITION, INFORMATION ON INGREDIENTS

Chemical Name	Percent	REG. Y/N	CAS #	OSHA (PEL)	ACGIH (TLV)	CARC. Y/N
Arsenic Trioxide	<1	Yes	1327533	10 ug/m^3	200 ug/m^3	Yes
Lead Oxide	>50	Yes	1317368	50ug/m^3	150ug/m^3	No
Potassium Oxide	1-10	No	12136457	N/A	N/A	No
Silica	20-50	Yes	014808607	.1mg/m^3	.1mg/m^3	No
Sodium Oxide	1-10	No	1313593	N/A	N/A	No

Regulated as per lists: OSHA 29 CRF 1910 Subpart Z: ACGIH: NTP and IARC

SECTION 3 PHYSICAL DATA

Boiling Point: not applicable
Vapor Pressure: not applicable
Vapor Density: not applicable
Solubility in water: not applicable
Specific Gravity: N/A
Melting Point: 446°C
Physical State: solid with a **density of 3.86g/cm3**
Appearance and Odor: Various forms and shapes with no odor

SECTION 4 FIRE AND EXPLOSION HAZARD DATA

Flash Point: not applicable
Auto ignition temperature: not applicable
Flammable limits / % volume in air: not applicable
Extinguishing media: This material is non-combustible

Special fire fighting procedures: Use extinguishing media that is appropriate for the classification of the surrounding fire. Inorganic glass is non-combustible.

Unusual fire and explosion hazards: There is a possibility of flying glass fragments if hot glass comes in contact with water or carbon dioxide extinguishing media.

SECTION 5 HEALTH HAZARD DATA

Route(s) of entry and Effects of overexposure:

INHALATION: Primary effects are those of lead:

Acute: Nausea, headache, cramps, dizziness, weakness and diarrhea.

Chronic: Damage to liver and kidney, blood forming organs, reproductive system.

INGESTION:

Primary effects are those of lead. Ingestion may cause vomiting, diarrhea, depressed circulation and in severe cases shock, coma, paralysis and cyanosis.

SKIN:

Primary effects are those of arsenic. Arsenic has been known to cause itching, pigmentation and cancerous changes of the skin. Glass dust may cause irritation.

EYE:

May cause irritation.

FIRST AID:

Inhalation**: Remove from exposure. Biological monitoring and medical exam may be required for excessively overexposed persons.**
Ingestion**: Contact physician immediately**
Skin**: Wash with soap and water. Get medical attention if irritation persists.**
Eye**: Flush well with running water. Get medical attention if irritation persists.**

SECTION 6 SPILL, LEAK AND DISPOSAL CONSIDERATIONS

Spill or leak procedures: No special precautions.
Waste Disposal: Follow Federal, State and Local regulations.

SECTION 7 SPECIAL PROTECTION INFORMATION

Engineering controls:

Use local exhaust ventilation, hood or equipment enclosure to avoid dispersal of fibrous or other glass particulates into the workplace air.

Personal Protective Equipment:

Respiratory: If glass dust or particulates are above the OSHA permissible exposure limits, use a NIOSH approved respirator for dust and fibers.

Eye Protection: Industrial safety glasses that meet ANSI Z87 standards.

Protective Gloves: Recommend gloves for protection from sharp edges.

SECTION 8 SPECIAL PRECAUTIONS AND COMMENTS

Reactivity:

This is a stable material. Glass is inert to many chemicals, but may react to hot, strong alkaline solutions and with hydrofluoric, fluosilicic and phosphoric acids.

Hazardous decomposition or byproducts: may emit metal oxide fumes when heated to high temperatures.

Comments:

Inorganic glass is an amorphous, inorganic and usually transparent or translucent substance consisting of a mixture of silicates or sometimes borates or phosphates formed by fusion of silica and various types of oxides with a flux and a stabilizer, into a mass that cools to a rigid condition without crystallization.

SF2 - Schott 2000

Diagram n (λ) | n calculation | Diagram τ (λ) | τ calculation | Analogue search

Main parameters

n_d = 1.647689	V_d = 33.84	$n_F - n_C$ = 0.019135	Coloring:
n_e = 1.652219	V_e = 33.59	$n_{F'} - n_{C'}$ = 0.019411	0.37 - 0.33 mkm.

Coefficients of dispertion formulas

Type: Sellmeier
Spectral range: 0.3650146 - 2.3254 mkm.
C1 = 1.40301821 C2 = 0.231767504 C3 = 0.939056586 C4 = 0.0105795466 C5 = 0.0493226978
C6 = 112.405955

Refraction index		Relative partial dispertion		Transmittance: 10 mm		Transmittance: 25 mm	
$n_{2.3254}$	1.610034	$P_{C,t}$	0.7045	$\tau_{2.3254}$	0.89	$\tau_{2.3254}$	0.74
$n_{1.9701}$	1.614936	$P_{C,A'}$	0.3172	$\tau_{1.9701}$	0.959	$\tau_{1.9701}$	0.9
$n_{1.5296}$	1.620551	$P_{d,C}$	0.2922	$\tau_{1.5296}$	0.998	$\tau_{1.5296}$	0.994
$n_{1.06}$	1.627661	$P_{e,C}$	0.5290	$\tau_{1.06}$	0.999	$\tau_{1.06}$	0.998
n_t	1.628613	$P_{g,d}$	1.2962	$\tau_{0.7}$	1	$\tau_{0.7}$	0.999
n_s	1.632885	$P_{g,F}$	0.5885	$\tau_{0.66}$	0.999	$\tau_{0.66}$	0.998
n_r	1.639020	$P_{h,g}$	0.5139	$\tau_{0.62}$	0.999	$\tau_{0.62}$	0.998
n_C	1.642096	$P_{i,g}$	1.4515	$\tau_{0.58}$	0.999	$\tau_{0.58}$	0.998
$n_{C'}$	1.642971	$P_{C',t}$	0.7503	$\tau_{0.54607}$	0.999	$\tau_{0.54607}$	0.998
$n_{0.6328}$	1.643794	$P_{e,C'}$	0.4832	$\tau_{0.5}$	0.999	$\tau_{0.5}$	0.997
n_D	1.647522	$P_{F',e}$	0.5311	$\tau_{0.46}$	0.997	$\tau_{0.46}$	0.992
n_d	1.647689	$P_{i,F'}$	1.9799	$\tau_{0.4358}$	0.994	$\tau_{0.4358}$	0.986
n_e	1.652219			$\tau_{0.42}$	0.993	$\tau_{0.42}$	0.983
n_F	1.661231			$\tau_{0.4047}$	0.989	$\tau_{0.4047}$	0.973
$n_{F'}$	1.662382			$\tau_{0.4}$	0.988	$\tau_{0.4}$	0.97
n_g	1.672493			$\tau_{0.39}$	0.979	$\tau_{0.39}$	0.95
n_h	1.682328			$\tau_{0.38}$	0.959	$\tau_{0.38}$	0.9
n_i	1.700269			$\tau_{0.37}$	0.93	$\tau_{0.37}$	0.84
$n_{0.3341}$	-----			$\tau_{0.365}$	0.91	$\tau_{0.365}$	0.79
$n_{0.3126}$	-----			$\tau_{0.35}$	0.76	$\tau_{0.35}$	0.5
$n_{0.2967}$	-----			$\tau_{0.3341}$	0.25	$\tau_{0.3341}$	0.03
$n_{0.2804}$	-----						
$n_{0.2483}$	-----						

Mechanical

Density: 3.86 g/cm^3
Poisson coef.: 0.227
Young module: 550 Pa*10^8
Knoop hardness: 410
Optical stress coef.: 2.62 1/Pa*10^{12}
Abrasion: 2

Chemical

Climatic resistance: 1
Staining: 0
Resistance to acids: 2

Resistance to acids: 2
Resistance to alkalis: 2.3
Phosphate resistance: 2

Temperature coefficient of linear expansion	
Temp. range, C	Value, 1/C*10^-7
-30 ~ 70	84
20 ~ 300	92

Temperature coefs. of n_{abs}		
Temp. range, C	Wave length, mkm.	Value, $1/C*10^{-6}$
-40 ~ -20	g	3.7
20 ~ 40	g	5.4
60 ~ 80	g	6.4
-40 ~ -20	e	1.8
20 ~ 40	e	3.2
60 ~ 80	e	4.1
-40 ~ -20	1.06	0.1
20 ~ 40	1.06	1.3
60 ~ 80	1.06	2

Temperature coefs. of n_{rel}		
Temp. range, C	Wave length, mkm.	Value, $1/C*10^{-6}$
-40 ~ -20	g	6
20 ~ 40	g	6.9
60 ~ 80	g	7.6
-40 ~ -20	e	4
20 ~ 40	e	4.6
60 ~ 80	e	5.2
-40 ~ -20	1.06	2.3
20 ~ 40	1.06	2.7
60 ~ 80	1.06	3.1