Subject: Re: L1100162-v1, VRB question: acceptable to not vacuum bake the CP and ERM to ESD flex connector bond?
From: Zucker Michael <zucker_m@ligo.mit.edu>
Date: 8/3/2011, 1:24 PM
To: Dennis Coyne <coyne@ligo.caltech.edu>
CC: John Worden <worden_j@ligo-wa.caltech.edu>, Mike Meyer <mmeyer@ligo-la.caltech.edu>, Fred Raab <raab_f@ligo-wa.caltech.edu>, Mike Zucker <mike@ligo.mit.edu>, Rainer Weiss <weiss@ligo.mit.edu>, Norna Robertson <nroberts@ligo.caltech.edu>, Phelps Margot <mphelps@ligo.caltech.edu>

Dennis- Looks like a reasonable argument for similarity, so probably OK.

One small red flag: you mention the final curing is "more rigorous" than the mfg. spec. Now, 182 C might just be
close to 360F or something, and 1.5 hours might be "enough"; or maybe DuPont really intends to bound it from both
directions (??).

If I understand correctly the Pyralux acrylic adhesives will be extremely temperature sensitive (far more so than
the polyimide). It may therefore be important to insure that they are never OVER-heated. Overheated acrylics
can break down and become seriously nasty.

So it could be prudent to test a sample (say, in an RGA-equipped chamber) against the worst-case envelope of post-assembly
bakeout conditions, with safety margin, to insure that we could neither under--NOR over-bake an assembly "through" clean to "dirty"
again.

And also of course, insure through engineering and administrative means that we cannot pass anything that might have been
inadvertently overheated. Not that this ever happens, just saying.

It would then be (even more) airtight to say that in principle, NO subsequent step after the RGA of the component parts could possibly recontaminate the assembly, and thus that the risks of further bake/QA are unwarranted.

Mike

On Aug 3, 2011, at 3:50 PM, Dennis Coyne wrote:

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The basic concern is whether the Pyralux adhesive has been fully cured and outgassed during bonding the connector to the optic. Note that:

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3. A flex connector was bonded onto a LASTI ERM and an FTIR was conducted on its surface before and after, no contaminants were found on surface or barrel right next to connector.

Dennis, Margot, Norna

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Rai,
I guess that I wasn't clear enough. Our concern is that a vacuum bake would leave contaminant on the optic (in this case a CP or an End Reaction Mass, not an ETM). The only vacuum bake that we have done is on the cured ESD flex connector which has pyralux between two kapton sheets. We have not vacuum baked the pyralux to optic barrel bond and would prefer not to do so -- just an air bake.

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So my thinking was that you don't need to get much heat into the glass, just enough so that it does not keep the small volume of epoxy from heating up. Furthermore, I doubt it is very important to outgas the boundary layer of epoxy in contact with the glass; you really only care about getting the surfaces and most of the bulk epoxy baked. So, presuming the joint is on the barrel of the mirror rather than the face, an airstream ought to be able to do the epoxy outgassing without driving enough heat into the mirror to worry the first contact on the surfaces. Ya think?

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Date: 8/3/2011, 3:02 PM
To: fred.raab@ligo.org
CC: Dennis Coyne <coyne@ligo.caltech.edu>, John Worden <worden_j@ligo-wa.caltech.edu>, Mike Meyer <mmeyer@ligo-la.caltech.edu>, Mike Zucker <mike@ligo.mit.edu>, Rainer Weiss <weiss@ligo.mit.edu>, Norna Robertson <nroberts@ligo.caltech.edu>, Phelps Margot <mphelps@ligo.caltech.edu>

Not sure I buy it Fred. The polymers are all permeable, or else we could just paint everything with "good paint"

My nightmares are lately populated by nonequilibria. You chase something from point A and it hides at point B until later, whence it escapes. Your criterion of success is not the temperature or time, but what fraction of the total contaminant actually disappears.

BTW is the pyrolex stuff actually epoxy, or is it some PMMA derivative? The Dupont specs state "acrylic adhesive".

I do share your concern about warming up First Contact.

On Aug 3, 2011, at 5:34 PM, Fred Raab wrote:

> So my thinking was that you don't need to get much heat into the glass, just enough so that it does not keep the small volume of epoxy from heating up. Furthermore, I doubt it is very important to outgas the boundary layer of epoxy in contact with the glass; you really only care about getting the surfaces and most of the bulk epoxy baked. So, presuming the joint is on the barrel of the mirror rather than the face, an airstream ought to be able to do the epoxy outgassing without driving enough heat into the mirror to worry the first contact on the surfaces. Ya think?
>
> Fred
> ---
>
> On 8/3/11 2:23 PM, Dennis Coyne wrote:
>
> > We were thinking about a forced convective flow past the bond. The optic surfaces have been covered with first contact during the 2 hr cure time. However when baking for 48 hrs at 130C, the entire optic may get too warm to keep the first contact on. We will have to look into this.
> > Dennis Coyne
> > Chief Engineer, Advanced LIGO & LIGO Laboratory
> > California Institute of Technology
> > MC 100-36, 1200 E. California Blvd.
> > Pasadena, CA 91125 USA

Telephone 626.395.2034

On 8/3/2011 1:48 PM, Fred Raab wrote:

> Dennis and VRB'ers,
>
> Would it be a nutso idea to just use a heat gun to provide a hot air stream across the new pyralux joint, rather than heat the entire mirror? It might allow keeping the mirror surfaces mostly covered and allow the airstream carry away any removed contaminants. It would require a bit of fixturing work to get the airstream method robust, but it might be cleaner than the air-bake oven solution.
>
> Fred
> ---
> On 8/3/11 12:50 PM, Dennis Coyne wrote:
>
> > LIGO-L1100162-v1
> >
> > To the VRB,
> > Our question:
> > Is it acceptable to not vacuum bake the Compensation Plates (CP) and End Reaction Masses (ERM) after the Electro-Static Drive (ESD) flex connector has been bonded to the barrel of the optic?
> >
> >
> > Background:
> > The current plan for providing the electrical connections to the Electro-Static Drive (ESD) on the
> > Compensation Plates (CP) and End Reaction Masses (ERM) is to bond a flex connector, with wires embedded in it, to the optic's barrel using Pyralux adhesive. This provides strain relief for the wires that are soldered to the gold ESD pattern. T1100320-v2 is the current ESD connector bonding/soldering procedure. The Pyralux adhesive is included in LIGO vacuum compatible materials list (E960050
> > -v10 on page 15, E13 and will be modified to note use in both the BOSEM and the ESD connector).
> >
> > The flex connectors are layers of kapton and Pyralux with five wires sandwiched in between. They are cured at the vendor during lamination for 1.5 hrs at 182 degrees Celsius. Then at CIT these flex connector/wire assemblies are vacuum baked at 130C for 48 hrs and then RGA scanned. A set of five of these flex connector assemblies have passed their Class A RGA scan (
> > ICS bake-1800) with < 3e-12 torr-liter/sec/cable hydrocarbon outgassing rate
> > .

At CIT we then bond these cured connectors to the surface using an additional sheet of Pyralux in between the flex connector and the optic's barrel. The bonding is done at CIT for 2 hours at 200 degrees Celsius. If we require a subsequent vacuum bake and RGA scan to ensure that the flex connector to optic barrel bond is fully cured and outgassed, then we incur some additional risk:

1. Requires additional handling to get optic in and out of the oven
2. Any hydrocarbons that outgass during the vacuum bake will stick to the optical surfaces of
the CP and ERM. It is not clear whether or not these hydrocarbons can be removed without damage to the gold ESD pattern.
3. We do currently have a good and safe way to mount the optics in the vacuum bake oven at 200C. Metal mounts should not be used due to their differential thermal expansion, glass mounts cannot be used because optics have been known to actually stick to glass mounts after baking. A
Class-A cleaned teflon or PEEK mount (baked at 200C)
might be an option, but we would then bake the ESD and optic assembly at a lower temperature to minimize the outgassing from the mount, say 170C.

The basic concern is whether the Pyralux adhesive has been fully cured and outgassed during bonding the connector to the optic. Note that:

1. The curing of the Pyralux bond is more rigorous at CIT then at the manufacturer (two hours of 200 degrees Celcius versus 1.5 hours of 182 degrees Celcius at vendor)
2. The RGA test of the flex connector assembly passed outgassing requirements after 130C for 48 hrs. We could perform a 130C outgassing bake in air, immediately after the initial cure cycle.
3. A flex connector was bonded onto a LASTI ERM and an FTIR was conducted on its surface before and after, no contaminants were found on surface or barrel right next to connector.

Dennis, Margot, Norna

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Subject: Re: L1100162-v1, VRB question: acceptable to not vacuum bake the CP and ERM to ESD flex connector bond?
From: Margot Phelps <mphelps@ligo.caltech.edu>
Date: 8/3/2011, 3:49 PM
To: Zucker Michael <zucker_m@ligo.mit.edu>
CC: Dennis Coyne <coyne@ligo.caltech.edu>, John Worden <worden_j@ligo-wa.caltech.edu>, Mike Meyer <mmeyer@ligo-la.caltech.edu>, Fred Raab <raab_f@ligo-wa.caltech.edu>, Mike Zucker <mike@ligo.mit.edu>, Rainer Weiss <weiss@ligo.mit.edu>, Norna Robertson <nroberts@ligo.caltech.edu>

Hi Mike,
DuPont lists the following tolerances on time and temperature for bonding Pyralux:
Time: 1-2hours "at temperature"
Bonding Temperature: 182-199 degrees Celcius.
I picked the higher end of the time and temperature, the vendor picked a bit lower. I can ask them why they do not laminate at a higher temperature, the only reason I picked the upper limit was to make sure it was fully bonded.
Pyralux Spec Sheet Link:
http://www2.dupont.com/Pyralux/en_US/assets/downloads/pdf/LFcoverlay_H-73245.pdf
Margot

On Aug 3, 2011, at 1:24 PM, Zucker Michael wrote:

> Dennis- Looks like a reasonable argument for similarity, so probably OK.
>
> One small red flag: you mention the final curing is "more rigorous" than the mfg. spec. Now, 182 C might just be
> close to 360F or something, and 1.5 hours might be "enough"; or maybe DuPont really intends to bound it from both
> directions (??).
>
> If I understand correctly the Pyralux acrylic adhesives will be extremely temperature sensitive (far more so than
> the polyimide). It may therefore be important to insure that they are never OVER-heated. Overheated acrylics
> can break down and become seriously nasty.
>
> So it could be prudent to test a sample (say, in an RGA-equipped chamber) against the worst-case envelope of post-assembly
> bakeout conditions, with safety margin, to insure that we could neither under-- NOR over-bake an assembly "through" clean to "dirty"
> again.
>
> And also of course, insure through engineering and administrative means that we cannot pass anything that might have been

inadvertently overheated. Not that this ever happens, just saying.

It would then be (even more) airtight to say that in principle, NO subsequent step after the RGA of the component parts could possibly recontaminate the assembly, and thus that the risks of further bake/QA are unwarranted.

Mike

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>
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