

NFRC Interlaboratory Comparison on Optical Properties: Instructions to Participants

Introduction

The National Fenestration Rating Council (NFRC) requires periodic interlaboratory comparisons of optical measurements on glazing materials. All submitters of glazing-product data intended for use in calculation of window-product energy ratings must participate. This ILC shall cover the transmittance and reflectance over the solar wavelength range as well as the reflectance (emittance) in the thermal infrared.

Background

One of the provisions of NFRC 302: Verification Program for Optical Spectral Data specifies that all submitters of optical data “or their representatives” shall participate in a “round robin” or ILC. Generally, manufacturers of glazing materials have the equipment necessary to perform their own measurements. NFRC 302 allows manufacturers to submit their own measured data subject to a set of checks to ensure the accuracy of such data. In some cases the glazing manufacturer does not have the required equipment and so may choose to send the samples to a test laboratory. In other cases the manufacturer of the final product such as a laminate may ask a component supplier, often a glass manufacturer, to perform the measurements for them. In such cases the “representative” must have qualified by participating in the ILC. There are two exceptions that we make on occasion: (1) a new data submitter does not have to wait for the next ILC if they submit a set of samples with their first dataset for comparison at LBNL, or (2) if they have participated in an ILC conducted by some other independent organization.

One implication that will jump to the minds of the participants is that this ILC is in the nature of a test and that failure will result in disqualification. In extreme cases this may be true, but we tend to view the ILC as a positive and helpful process. Every reasonable attempt will be made to diagnose problems which turn up and to remedy those problems. If the cure is impractical or unaffordable by a particular participant, then they may indeed be forced to hire a test lab until a suitable remedy is available. What does it mean to successfully participate in the ILC? It would be nice to be able to go to the statement of accuracy in the relevant measurement standard for a simple answer, wouldn't it?

For the emittance, we refer to NFRC 301 which simply says to report the values to three decimal places. The usual interpretation of such a bare statement of error is that we know the answer to ± 0.001 , which we certainly do not. A recent ILC conducted by the European Thermes project stated that the spread in the emittance of the test samples was no better than 0.005. This was the result of a special measurement program in which the participants were instructed to ignore their usual procedures. We may not do this well on the first round because we will not attempt the drift correction procedures of Thermes at this time.

In the solar range NFRC 300 refers to ASTM E903 for measurement practice. This venerable standard, gives a lengthy discussion of possible sources of error. There is much of interest, but also some ambiguity. We can ignore the errors produced by using a simplified selected ordinate calculation because we all use a common weighted average calculation. In fact for this reason, we do not even ask the participants to perform these calculations themselves. We can also discount “errors” discussed in E903 produced by using a different solar spectral irradiance in the calculation than the one that exists locally; NFRC ratings are relative and all participants are equally affected by such errors. That leaves us with a measurement error as large as ± 0.02 as estimated by ASTM E903. The average participant will probably do much better than that; perhaps better than ± 0.005 . In contrast to the declining availability of dispersive infrared spectrometers, many of us have upgraded to more modern equipment for the solar range since E903 was written.

It is also time for NFRC to renew its optical property standards. The findings of this ILC will be critical to that effort. If nothing else, the important statements of error will be rewritten. The lapsed ASTM standards will be renewed through NFRC initiatives and participation of NFRC members on ASTM committees. With the cooperation of our European colleagues who have been very active over the past 4 years, we may be able to harmonize these standards to a large degree. One of the outcomes of the Thermes project is supposed to be a revision of CEN and ISO standards on emittance. This is very important because with FTIRs taking the place of dispersive existing standards such as NFRC 301 will become obsolete.

In any case, the immediate purpose of this ILC is to evaluate the current ability of data submitters to make accurate measurements. Accordingly, you will be asked to use your everyday measurement procedure at this stage. Unlike the Thermes ILC, for example, we are not doing research on how to improve the measurement process. Nevertheless this is or may be a concern and we will give it due consideration. One of the most commonly identified causes of systematic error is the reference mirror. For this reason we will ask that you perform two sets of reflectance measurements: one using your in-house reference and one using the mirror provided with the ILC sample set. Also we will ask you to answer some questions about your experimental setup and procedure to assist with diagnosis of errors.

Measurement Instructions

Sample Identification and Handling

You will receive two sets of samples: one for the solar range and the other for the thermal infrared. To eliminate a possible source of error everyone will measure the same samples. To minimize the time needed to complete the ILC we are asking everyone to adhere to the schedule. You will receive your samples by appointment and you will have a maximum of one week to complete the measurements and send the samples on to the

next participant. Availability of equipment may change and so you will be contacted after you receive the samples with the name of the next participant.

The samples come from previous ILCs originated in Europe. It will be useful and interesting to compare our results with an extensive database of previous results. Also it will assist us in the elusive quest for international harmonization. Table 1 and table 2 identify the samples for the solar and infrared tests, respectively:

Table 1. Solar test samples.

Sample ID	Name	Description
M.H	Aluminum mirror	Glass substrate/Al
H.8.1	Antelior Argent	Pyrolytic TiO ₂ (St. Gobain)
H.8.2	Amiran	Antireflection coated glass (Schott)
H.8.3	Diamond glass	Uncoated clear float
H.8.4	CoolLite SKN	Double-Ag low-e (St. Gobain)
H.8.5	Planitherm Futur	Single-Ag solar-control low-e (St. Gobain)

Table 2. Emittance test samples.

Sample ID	Name	Description
M01	bare gold reference mirror	Glass substrate / 20 nm Cr / 100 nm Au
S01	Planitherm Std	Single-Ag low-e
S02	SS-108	SS/SiN medium-e
S03	Mirror SGR	Ag/SiN low-e
S04	Ecologique	SnO ₂ :F, low-e
S05	SKN-165B	Double-Ag low-e
S06	Planilux	Clear float, Sn side

Participants should take extreme care in handling samples and the use of gloves is recommended. Use especial care in handling the gold reference mirror which has been packed so that the central area of the coated surface is suspended in air. Please replace the mirror in the same position that it was shipped. After opening the box, all samples should be stored in a clean, dry (desiccated) environment. Do not clean the samples. If a sample becomes visibly damaged or stained, please contact LBNL to discuss cleaning procedures or possibly return the set rather than forward to the next participant.

Measurement Procedure

As discussed above, our immediate purpose is to assess current measurement practice. Accordingly, we will give very few instructions on specific measurement parameters. Follow your usual measurement procedure as you would for a submission to the IGDB following the guidelines of NFRC 300 and NFRC 301. Carefully document the procedure

and describe the equipment used as discussed in the section on Reporting of Results. Each participant should measure the transmittance and the reflectance from each side of the solar-range sample set and the reflectance (emittance) from the coated side of the infrared sample set.

Data Recording

NFRC 300 and 301 require you to collect data at certain minimum intervals. The purpose of this minimum is to ensure that average parameters such as solar and visible transmittance will be calculated accurately using Window 5/6. Some participants choose to discard all but these minimum wavelengths. In this case we will ask you to keep all data. With this one exception, prepare a file just as you would for an ordinary data submission to the IGDB using the standard file format.

Schedule

Prior to receiving the sample sets each participant will make an appointment for measurement. You will be asked to perform all measurements within one week. You will be contacted by the ILC coordinator when you are expected to receive the samples to check on safe delivery and to answer any questions before proceeding with the tests. You will also be given full instructions of mailing the samples to the next participant. You will also be asked to complete your data preparation within two weeks of completing the measurements. If you have any questions please direct them to:

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Laboratory Information

Please answer the following questions. Feel free to scribble answers on this sheet:

Solar range spectroradiometer:

1. Manufacturer of uv-vis-nir spectrometer:
2. Model of uv-vis-nir spectrometer:
3. Manufacturer of integrating sphere accessory:
4. Model of integrating sphere accessory:
5. angle of incidence for reflection:
6. measurement parameters, e.g., slit width, gain, sensitivity, speed, resolution
7. warm up time:
8. do you correct for 0% reference:
9. how often do you remeasure 100% reference:

Infrared spectrometer

1. Dispersive or FTIR:
2. Manufacturer of spectrometer:
3. Model of spectrometer:
4. Manufacturer of specular reflectance accessory:
5. Model of specular reflectance accessory:
6. Angle of incidence for specular reflectance accessory
7. measurement parameters, e.g., resolution, number of scans.
8. instrument purge:
9. warm up time:
10. do you correct for 0% reference:
11. how often do you remeasure 100% reference: