Comments on ISO/TC 172 SC 3

Summary- ISO/CD 17328.2 offers a useable process for the measurement of refractive index by documenting a version of the minimum deviation technique.

This document captures the basics configuration of a capable instrument and outline of the process.

There are a few areas in the specification which could use more elaboration to establish better control of a few error contributors.

Section 4.4 (Wavelength of light beam for measurement)-

This section states the need to 'measure at least 3 wavelengths that make it possible to calculate refractive index of arbitrary wavelength by curve fitting in the spectral range.'

This section does not need to be part of the standard given that it does not add value to the measurement process and the need will vary depending on the application and material properties.

When a material only needs to be tested at a single wavelength (laser applications come to mind) there is no need to measure outside the application wavelength.

In other situations 3 wavelengths may not be enough to accurately cover the dispersion in the band and could give a poor fit in between the data points, especially near the materials band gap.

Section 5.2 (Surface Accuracy)-

This section states the flatness of the incident and exit plane of the sample shall be measured with an interferometer and meet a specification of 150nm P-V or less.

There should be some work to look into the effects of Clear Aperture (C.A), meaning what percentage of each face must meet this specification and at what point does poor flatness outside the C.A. affect the measurement and to what degree. (I.e. if a part flatness meets the 150nm P-V over 80% of the C.A. but then degrades to 1um, how would this affect the RI values)

This effect contributes to the transmitted wavefront error, and can affect the measurement of the refracted angle. It also will affect the measurement of the Apex angle adding even greater uncertainty into the final refractive index value.

While it is still commonplace for optical surface flatness to be specified in terms of P-V, it may yield more repeatable results to define flatness in terms of RMS or some other average surface flatness parameter.

Also, it may help to state a minimum number of data points and filter settings to measure the flatness to take into account for potentially low sampling due to low resolution camera settings of various interferometers or large ratio of test to reference beam diameter.

Section 6 (Test Report)-

This section states the need to measure the sample temperature. However, any probe on the surface will not necessarily show the temperature gradient that may exist across a sample.

For this reason it may be prudent to specify a minimum soak time on the instrument. Even if a sample has been in the lab for a long period of time before testing, the handling of the part during placement into the instrument could add a gradient to the sample. When trying to achieve very higher levels of accuracy or dealing with samples the exhibit a large dn/dT this can be critical.

Other comments- Other variables that may need to be at least mentioned if not addressed that can be large contributors to error:

1. Systematic errors:
    a. Mis-alignment of the detector, collimator and samples rotation axis.
    b. Definition of how well collimated the collimated beam is.
    c. Quality of focusing optics.
    d. Signal to noise of Detector/ Camera

2. Dispersion- it is important to note when calculating uncertainty, the amount of dispersion (FWHM of a grating slit for example) can have a varying affect on the measured refracted angle depending on the correlating dispersion of the sample material at a given wavelength. This is due to the varying distortion of the refracted beam shape.