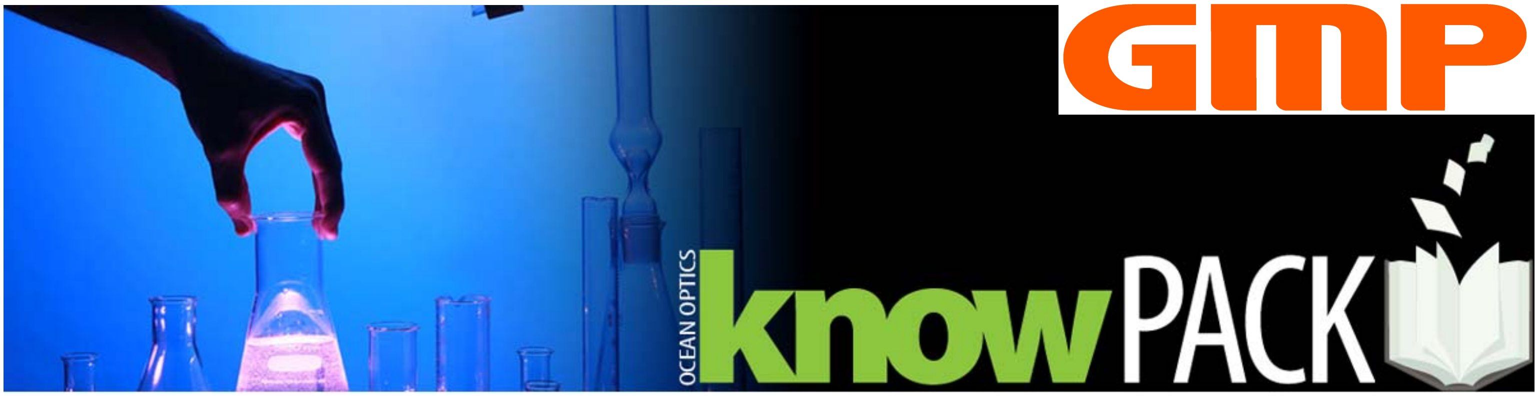
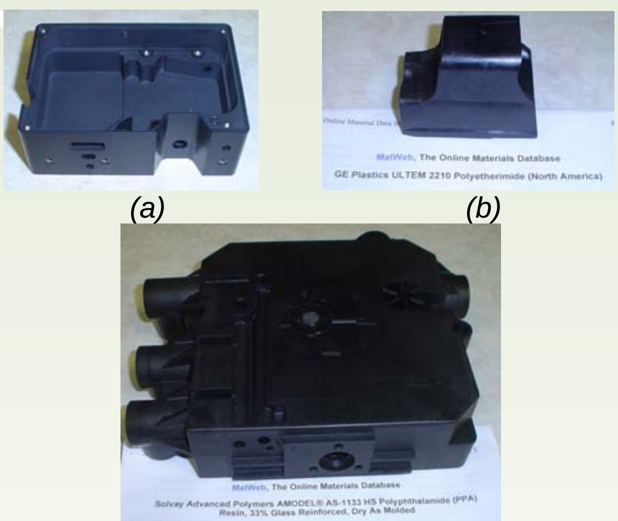


Reflection Measurements of Candidate Plastics for Replacing Aluminum as Structural Material in Optical Systems

Background

A coated aluminum sample and two samples of differing fiberglass -- reinforced thermoplastics (FRTP) were supplied for testing, as shown in *Figure 1*. The purpose of this study is to perform both specular and diffuse reflection measurements on the samples, using the aluminum sample as a reference, to assess the potential of these plastics as a new material for optical components and applications.



(a) *(b)*

Figure 1.
Samples (a) aluminum (b) FRTP1 plastic, and (c) FRTP2 plastics

Experimental Procedure

The samples were analyzed using a HR2000CG-UV-NIR spectrometer, three different light sources, (DH-2000, HL-2000, and LS-1), a 400 micron reflection probe with custom measurement sleeve (as seen in the figure below), and SpectraSuite, all pictured in *Figure 2*. The custom sleeve's purpose was two-fold. First, the intricate nature of the plastic samples necessitated a probe holder that was able to fit in tight spaces. Secondly, the sleeve fixed the distance between the reflection probe face and the sample ensuring that the reflection data was collected at a consistent distance from all surfaces (a critical element when comparing reflection data).

Figure 2. Experimental setup

Results

The measurements are shown below in *Figure 3 – Figure 8*. The plots are organized in groups of three corresponding to a common reflectance standard, either STAN-SSH or WS-1, and light source. For instance, *Figure 3 (a) – (c)* shows the measurement data for each sample for the DH-2000 light source with the STAN-SSH standard (i.e., specular reflectance standard).

Given the varying surface finishes on the plastic samples, multiple measurements for

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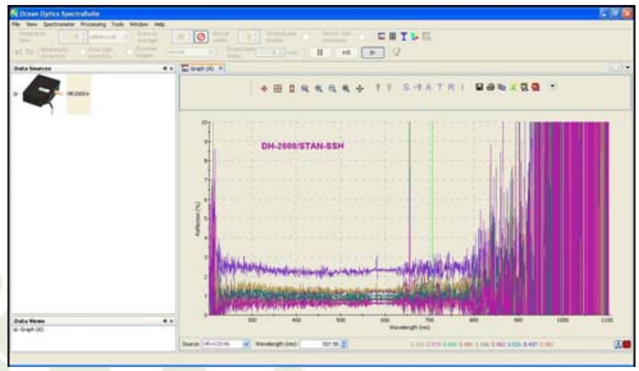
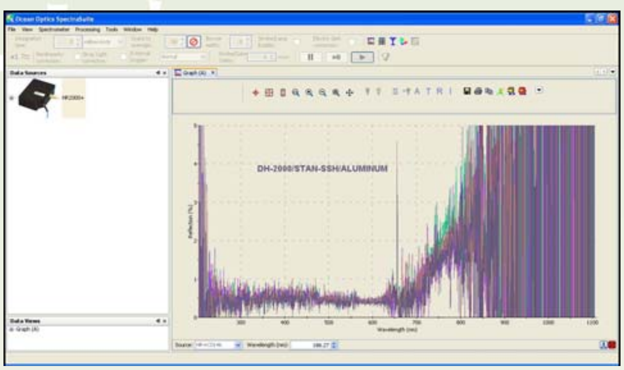
each plastic were performed with an emphasis on measuring as diverse a sample pool as possible (this is why there are multiple spectra in each plot). For the FRTP2 plastic a particular region on the sample had a matte surface finish, very similar to the sandblasted finish that is expected to be used in the final application. The last measurement for the FRTP2 plastic was always conducted at this matte region, which produced the best spectra for each measurement type and light source combination. For example, the orange spectrum in *Figure 6* (the spectrum with lowest diffuse reflectance) was taken from the matte region on the FRTP2 plastic.

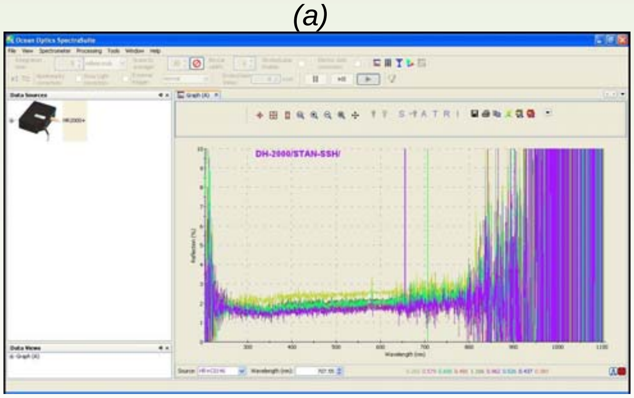


(c)

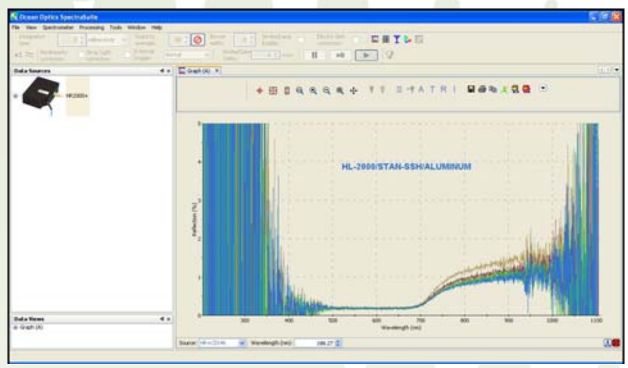
Figure 3. Specular reflection data: DH-2000, STAN-SSH, and (a) Aluminum sample (b) FRTP1 (c) FRTP2 plastics



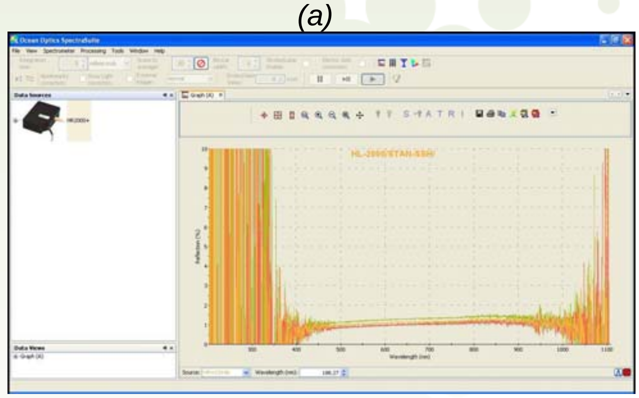
(a)



(b)



(a)



(b)

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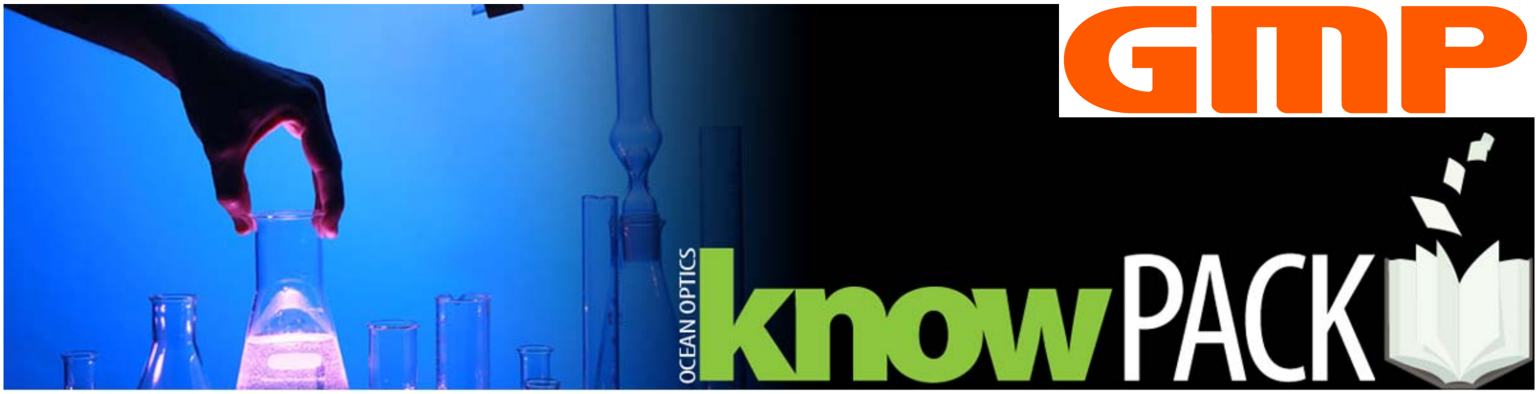
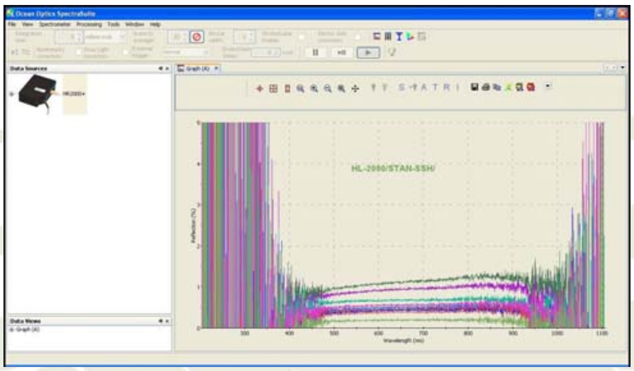
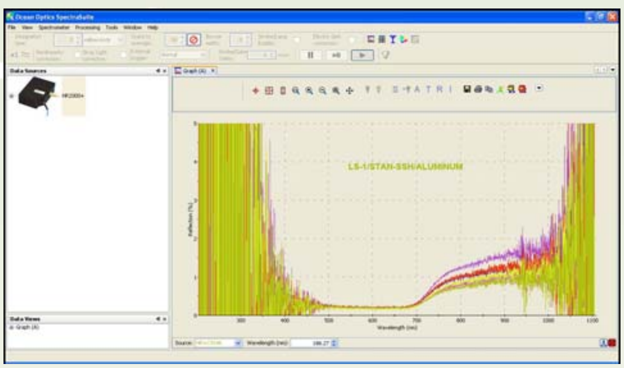


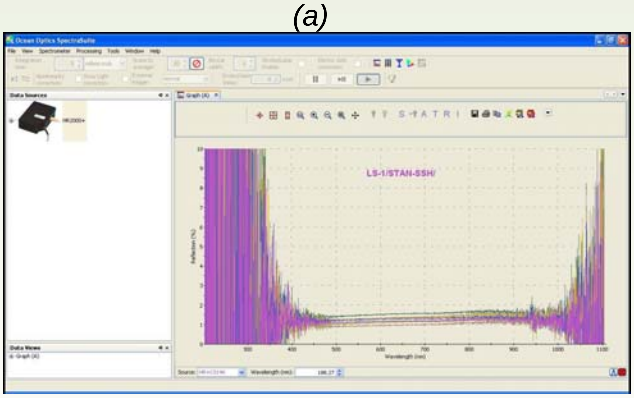


(c)

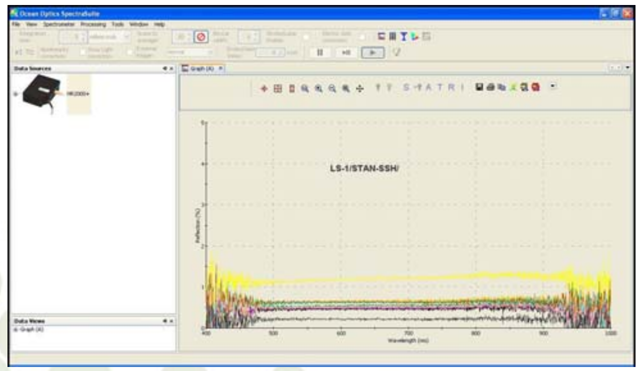
Figure 4. Specular reflection data: HL-2000, STAN-SSH, and (a) Aluminum sample (b) FRTP1 (c) FRTP2 plastics



(a)

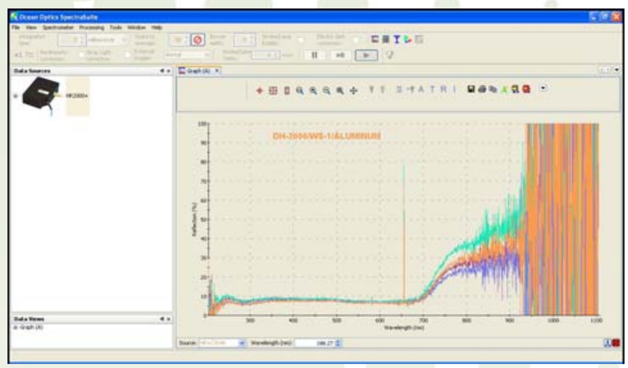


(b)

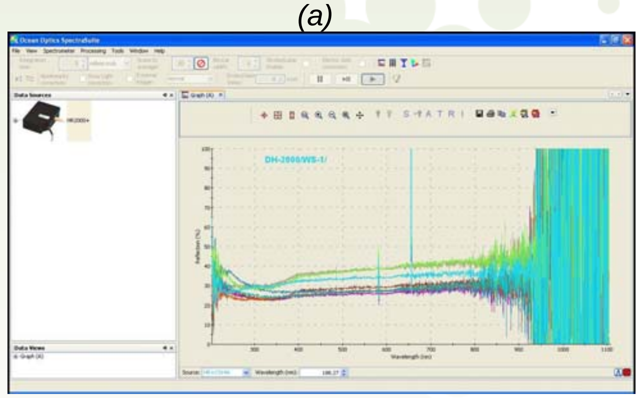


(c)

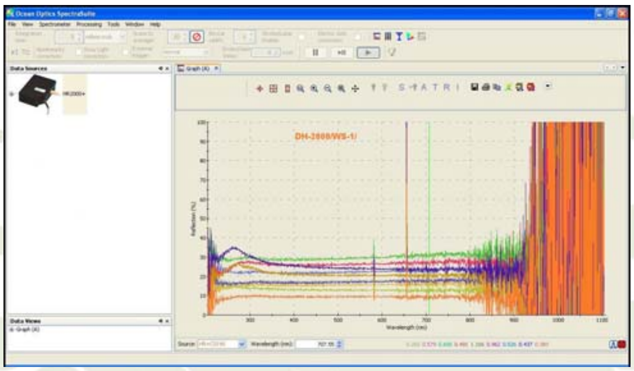
Figure 5. Specular reflection data: LS-1, STAN-SSH, and (a) Aluminum sample (b) FRTP1 (c) FRTP2 plastics



(a)

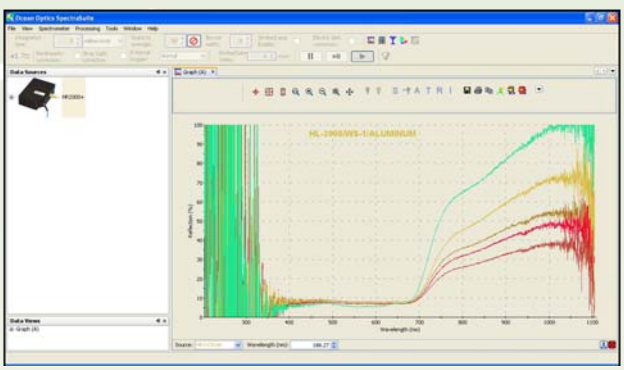


(b)

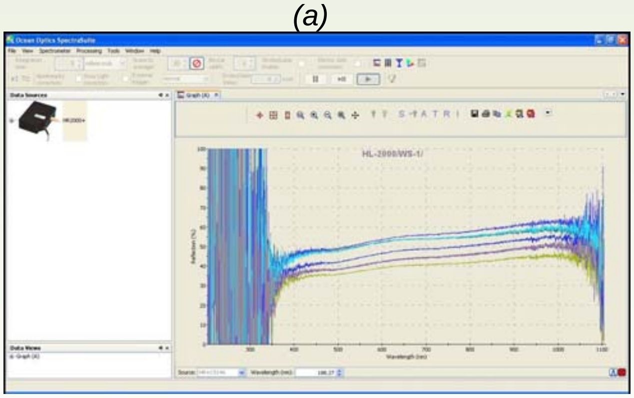


(c)

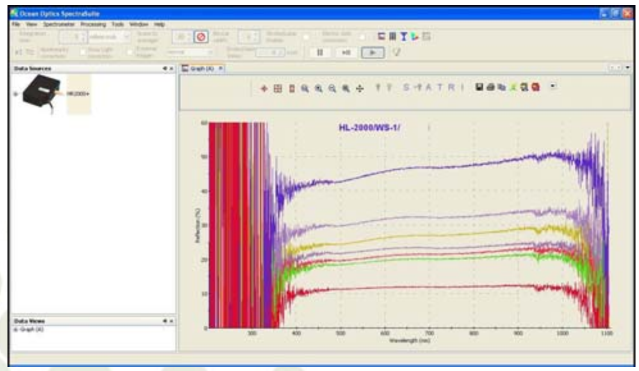
Figure 6. Diffuse reflection data: DH-2000, WS-1, and (a) Aluminum sample (b) FRTP1 (c) FRTP2 plastics



(a)

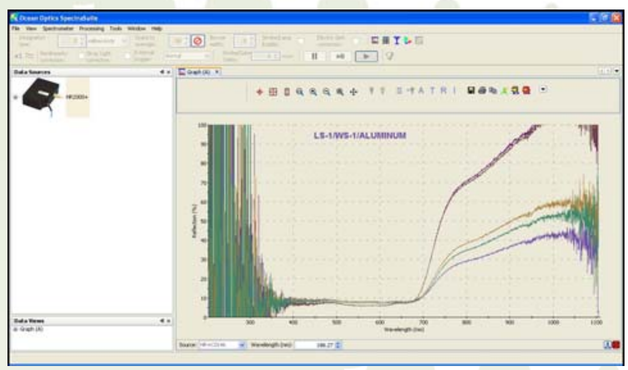


(b)

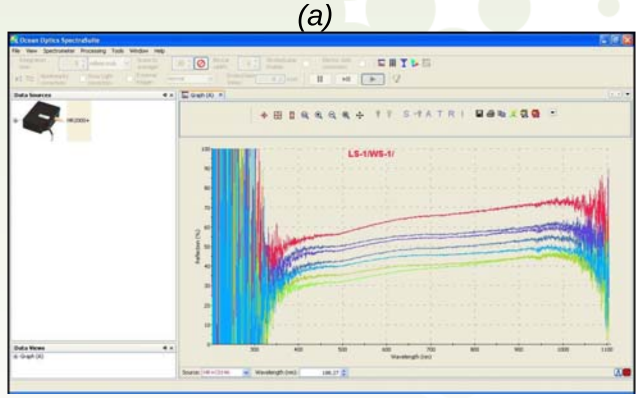


(c)

Figure 7. Diffuse reflection data: HL-2000, WS-1, and (a) Aluminum sample (b) FRTP1 (c) FRTP2 plastics



(a)



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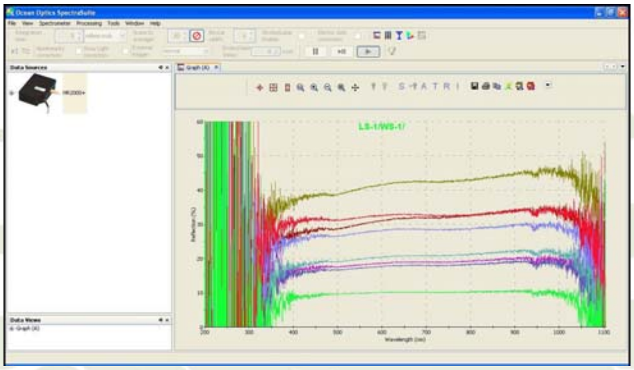

(c)

Figure 8. Diffuse reflection data: LS-1, WS-1, and (a) Aluminum sample (b) FRTP1 (c) FRTP2 plastics

Conclusions

There was significant variation in UV/VIS and NIR diffuse reflectance with surface finish for the plastic samples. The matte region of the FRTP2 plastic described earlier had reflectance properties very similar to the aluminum sample. The FRTP1 plastic sample did not have as wide a surface finish variation and no regions with a matte finish similar to the FRTP2 plastic for comparison. The specular reflectance performance was slightly less susceptible to surface finish variation, as expected, but the matte region of the FRTP2 plastic was superior and on par with the performance of the aluminum sample.

Based on the data presented both plastic samples have better diffuse and specular performance for NIR reflectance as compared to the aluminum sample, as can be seen in the sharp increase in NIR reflectance beginning at ~700 nm of the aluminum in *Figure 7 – Figure 8*. Again the matte region of the FRTP2 plastic had the best performance, in this case exceeding the performance of the current aluminum sample.

Overall, the matte region of the FRTP2 plastic had the best performance from the UV to the NIR of the plastics analyzed in the study, for both specular and diffuse reflectance. The increased absorbance in the NIR of the plastics is an attractive property, especially considering the poor performance of the current aluminum sample. The recommendation stemming from this study is that these plastics are potential materials for optical applications and components. Furthermore, an interesting extension of this study would be to acquire a FRTP2 and a FRTP1 plastic sample with the sandblasted finish retest to see the effects on the reflectance properties when surface finish variations are removed.

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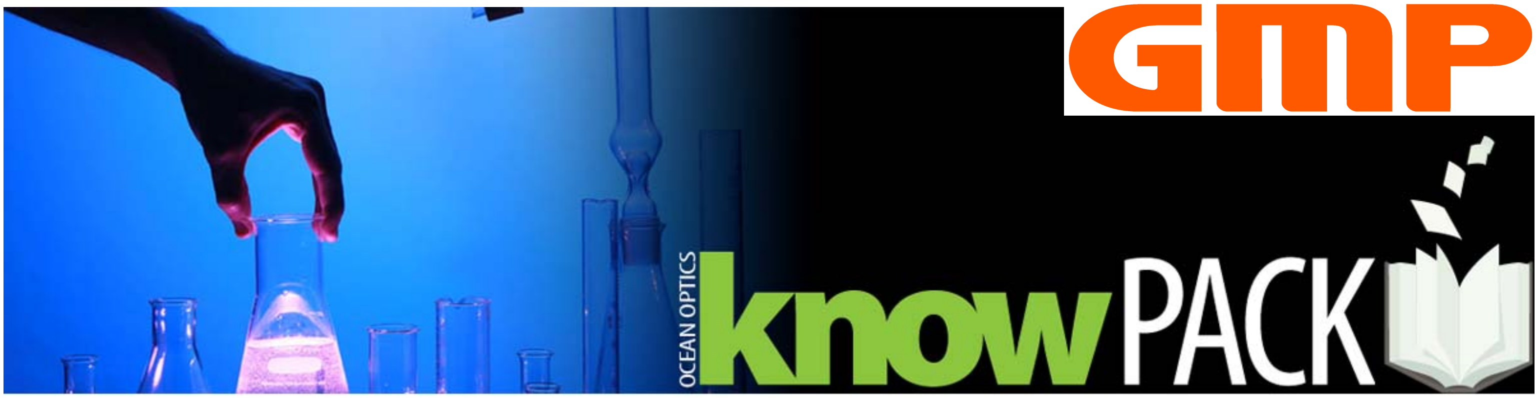

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