Meta-Standards for Color Rendering Metrics and Implications for Sample Spectral Sets

CIE US / Canada Meeting

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October 3, 2011

Abstract

Paper #2

Consideration of Meta-Standards for Color Rendering Metrics

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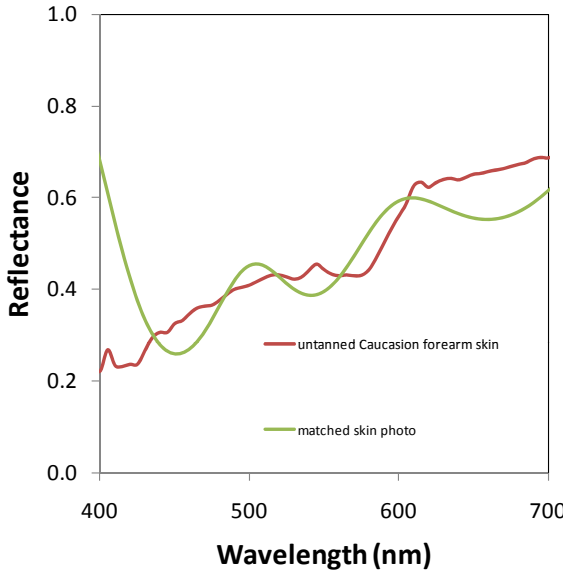
There is compelling, largely agreed-upon evidence that the CIE Color Rendering Index (CRI) is not a sufficiently accurate measure of the fidelity of color rendering. This has become particularly evident with the consideration of white light sources employing several narrow band light emitters. Although there are numerous suggestions for improving the CRI, the CIE has had difficulty reaching agreement on this matter. In this presentation an approach is suggested for reducing the difficulty, which is first to agree upon meta-standards for evaluation of proposed replacement metrics. Most experts already agree with the most basic requirement, which is the need to avoid ranking error. That is, if one light source is perceived, by most people, to render colors more accurately than another light source does (when both are compared to the color rendering of a defined ideal source), then the metric should not reverse that ranking. However this meta-standard, when taken alone, is not very discriminating because of the diversity and variability of human perception. As a result, secondary supplemental meta-standards are needed to make a selection decision. To be helpful, they should ensure that any new metric will be sensible, practical and will not cause undesirable unintended consequences in the future optimization of light source spectra. There already are proposed metrics for color rendering that satisfy all of these meta-standards to some degree. Therefore, it is hoped that if such meta-standards can be agreed upon, it will be possible to make quicker progress toward a significantly approved, widely accepted, replacement metric for the CRI.

Color Concepts Are Confusing!

- Two strong views of color and light sources:
  - Color matters a lot
  - Color matters little
- Both statements are correct, sometimes:
  - Some aspects of color *do* matter a lot to people
  - Some aspects of color *don't* matter all that much
- Confusion often leads to disagreement

An important case: “Flesh Tone”



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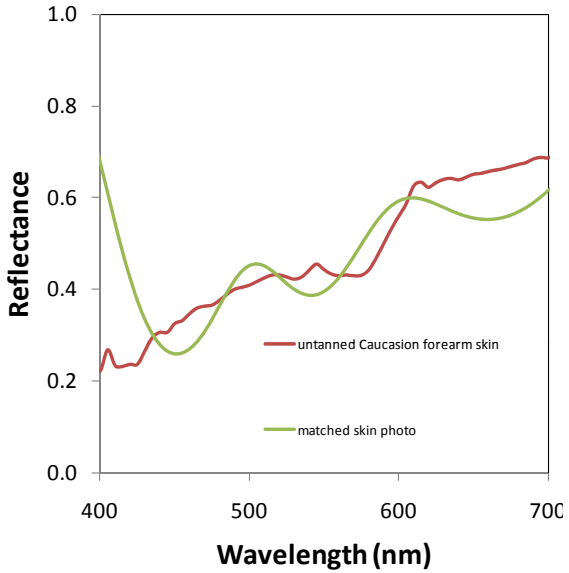

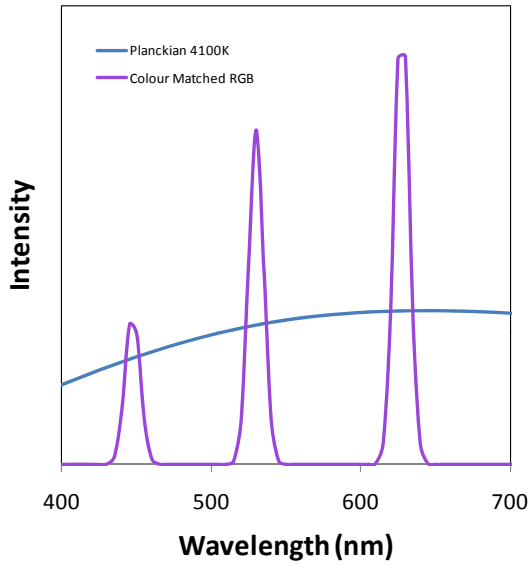

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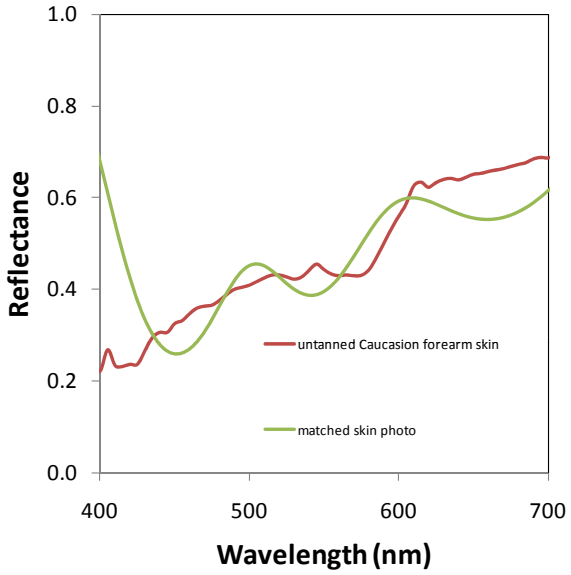

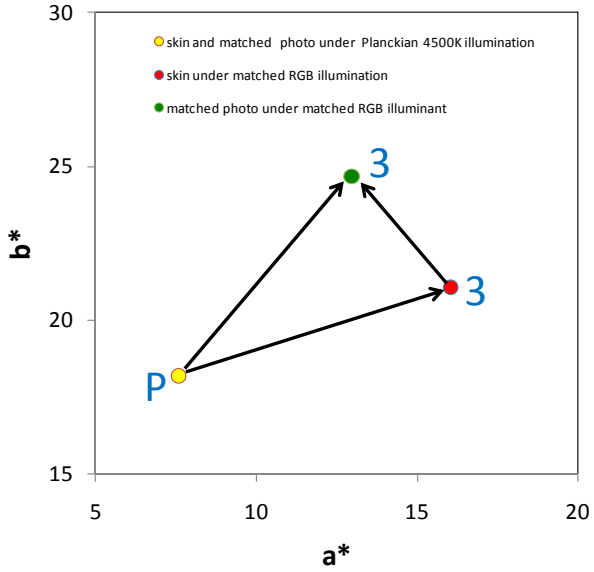

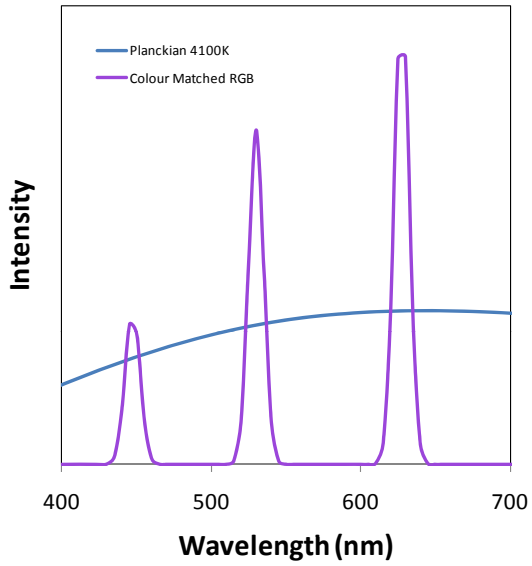

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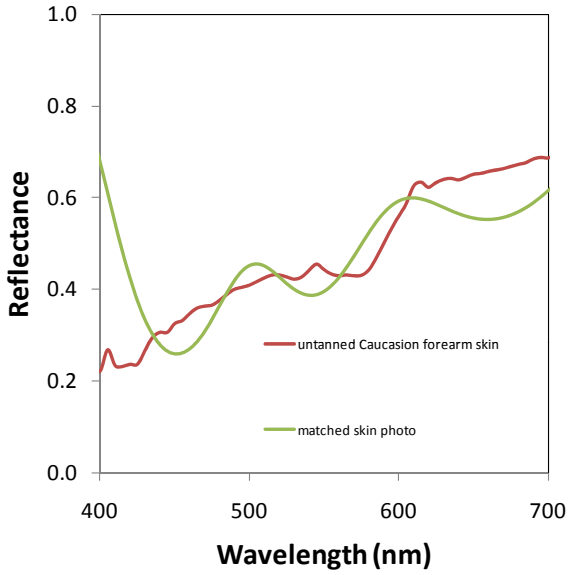

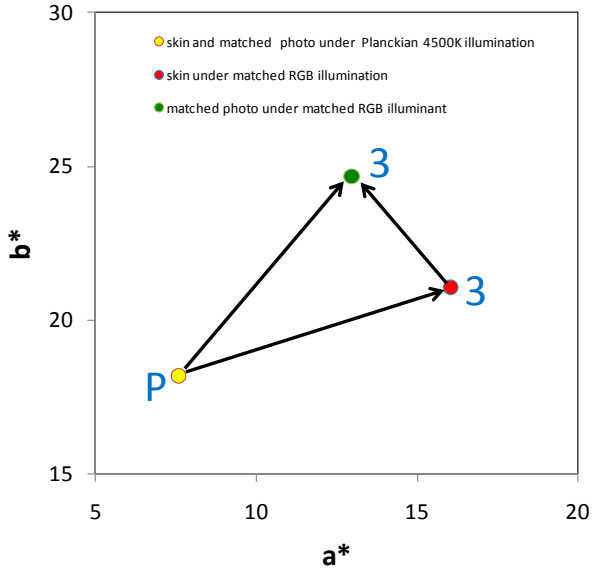

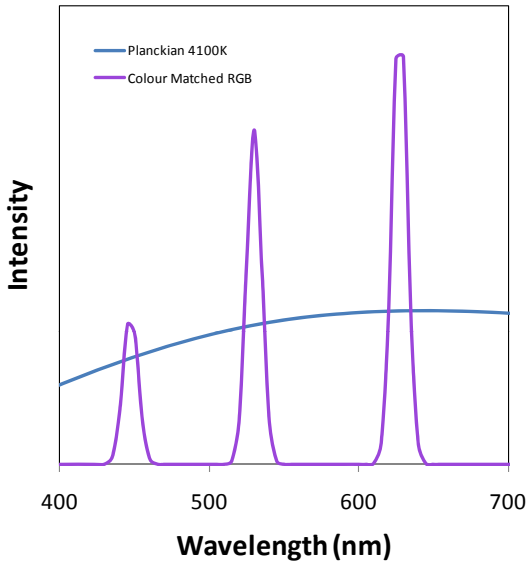

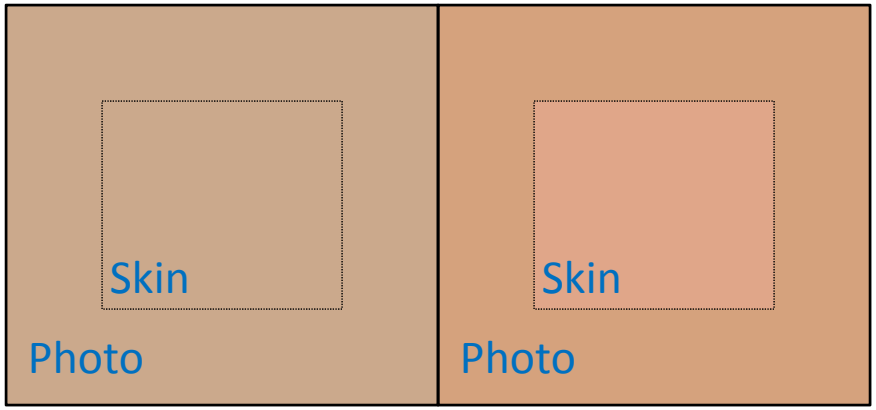

Key Ideas

- Different spectra can appear the same color
- But may *render* colors of surfaces differently
- We don’t adapt to poor color rendering
- This causes *some* people discomfort

TC 1-69 meeting July 13 2011: The TC now plans two reports:

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  - From Ronnier Luo's collaborative group);
  - fixing "outdatedness";
- An updated sample set;
  - Eliminates spectral response non-uniformity;
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- Surveys literature supporting this general view;
- Highlights the CQS (there are differing view on how to do so);
- Recommends the creation of a new TC on colour ***preference***.

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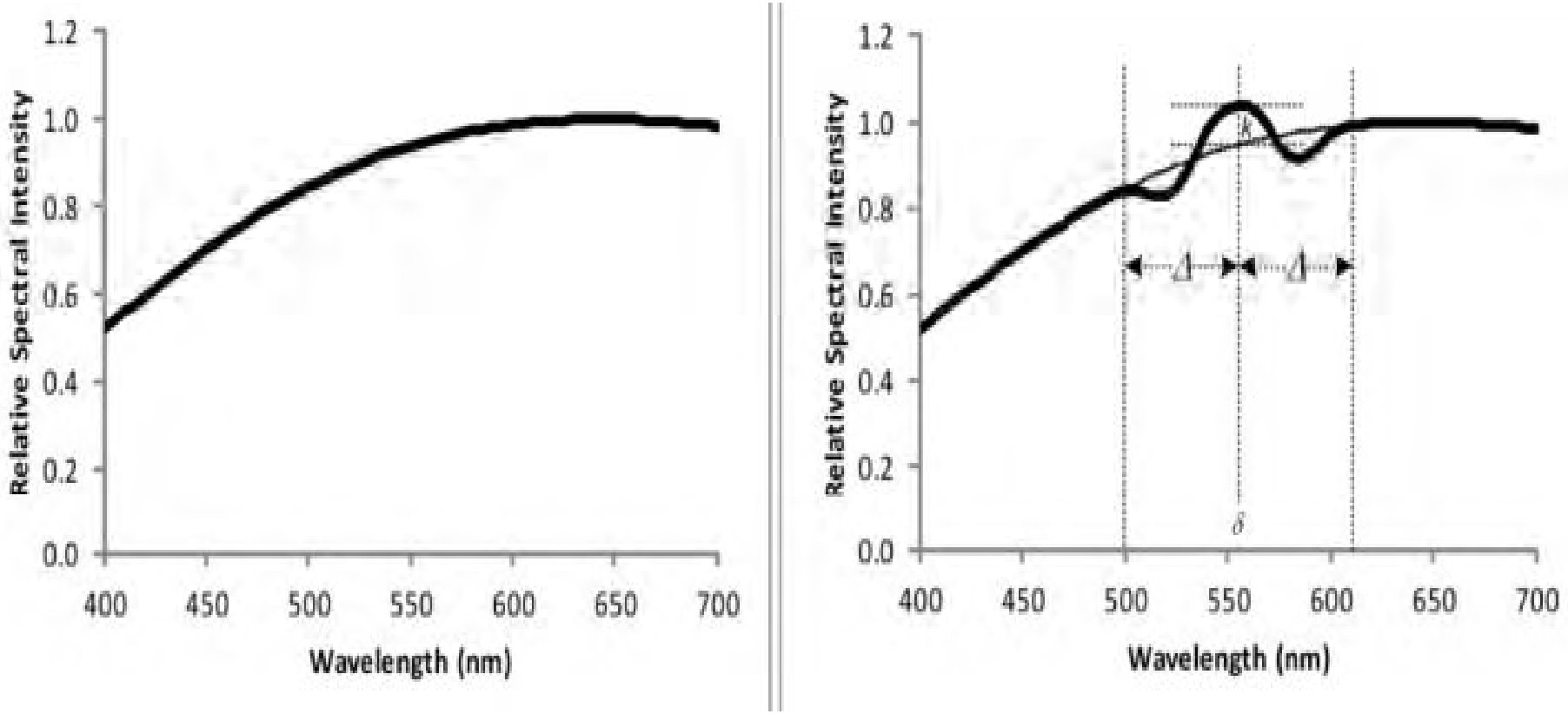
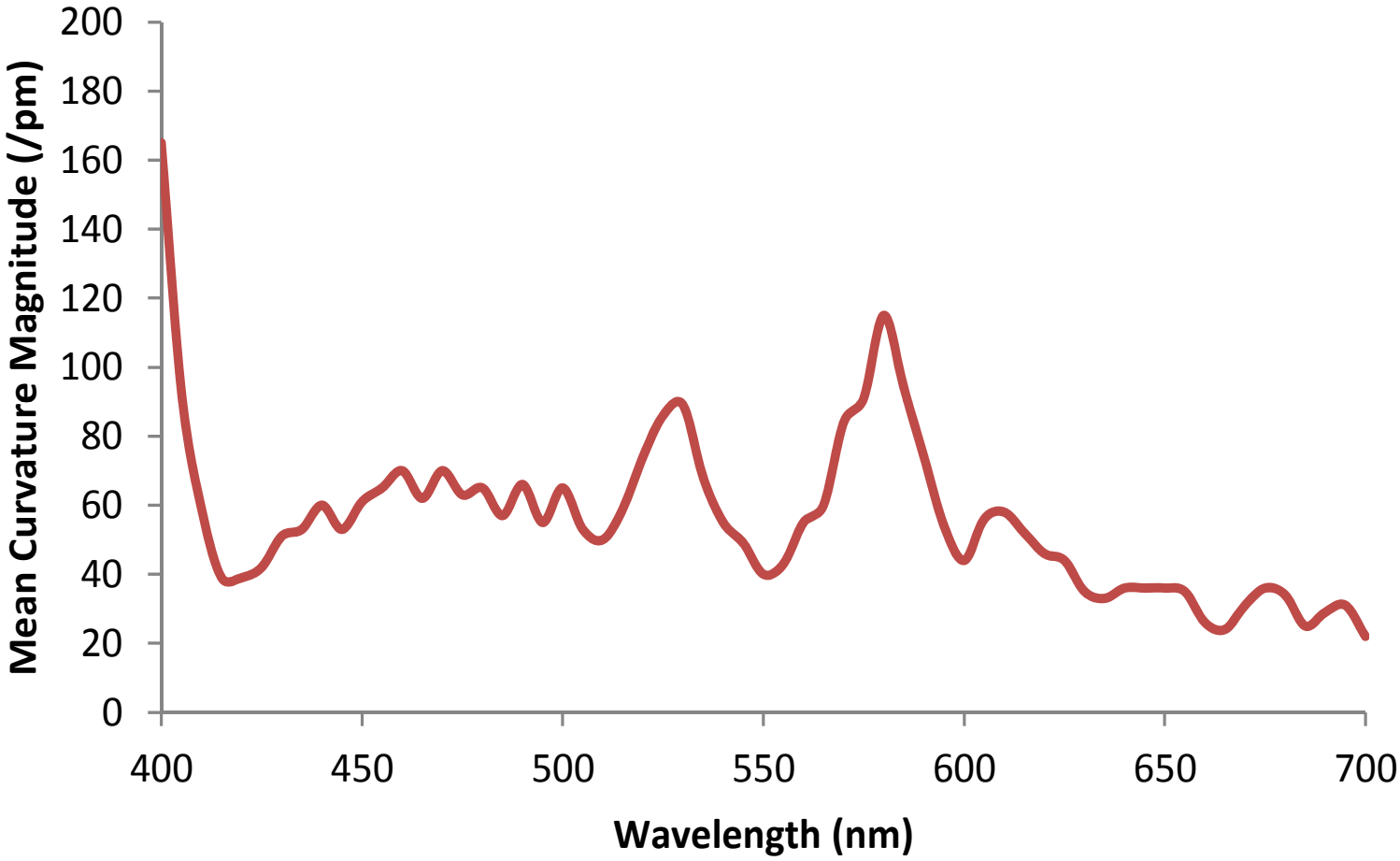
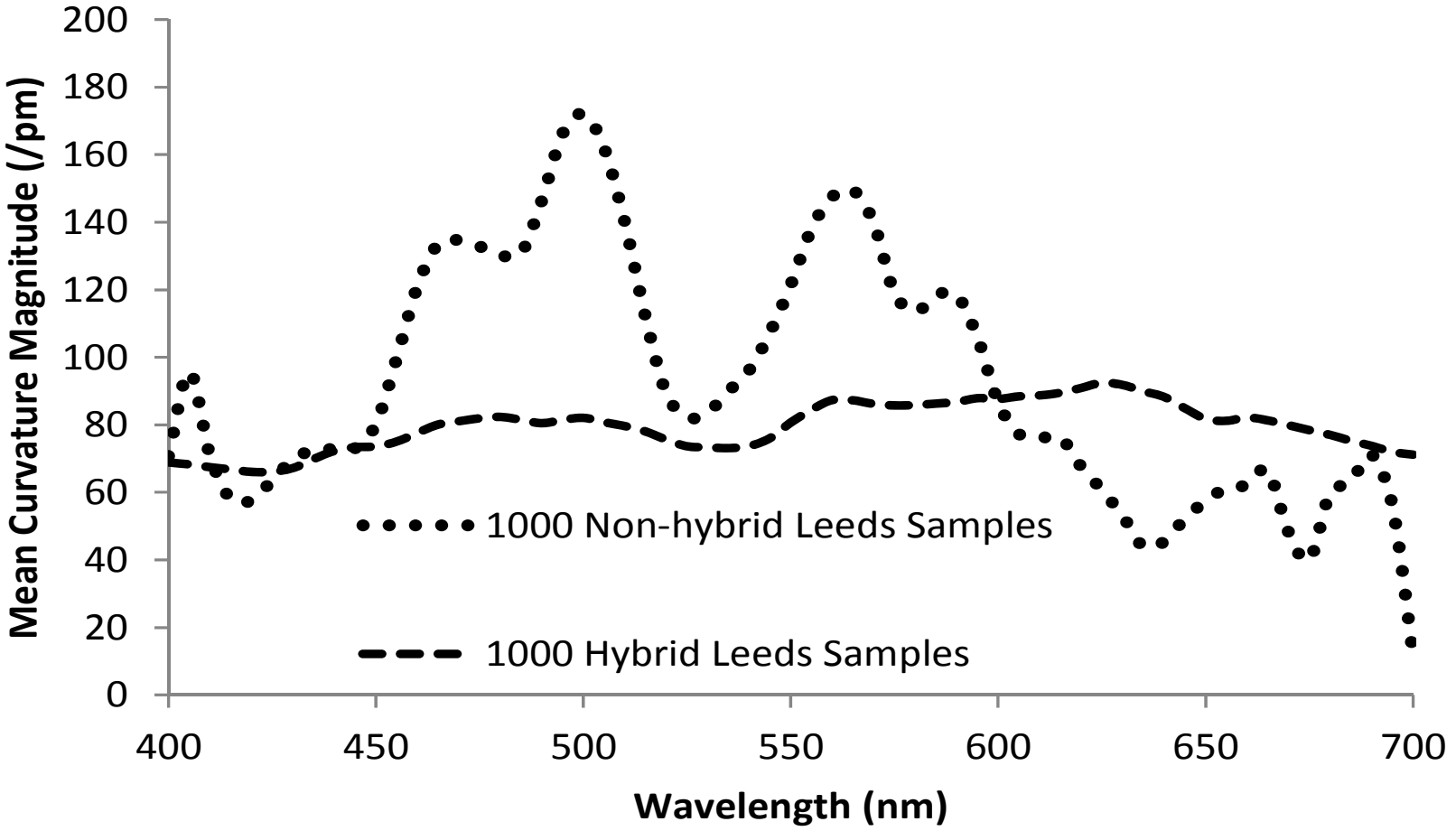


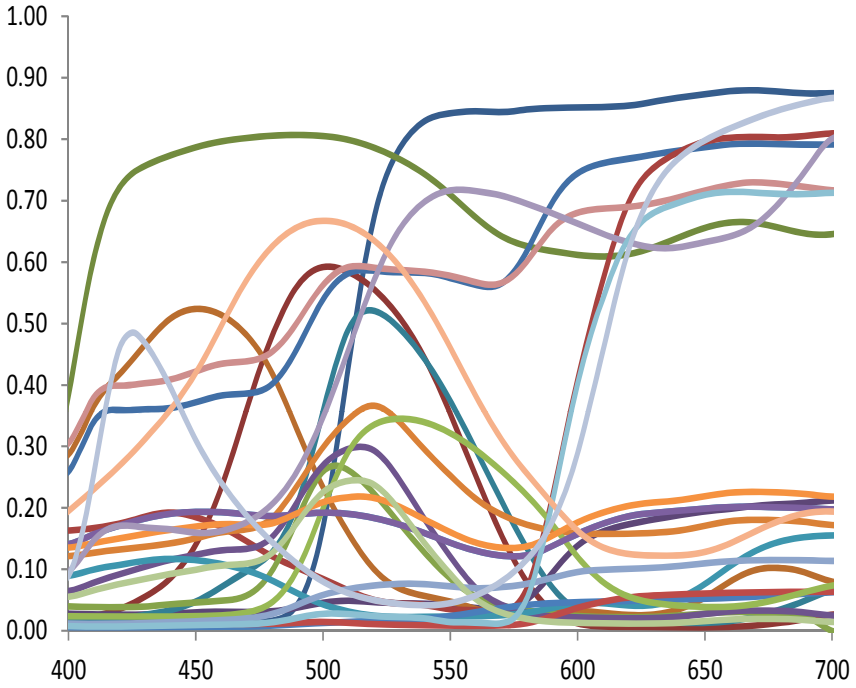
Color-Neutral Perturbation of Planckian



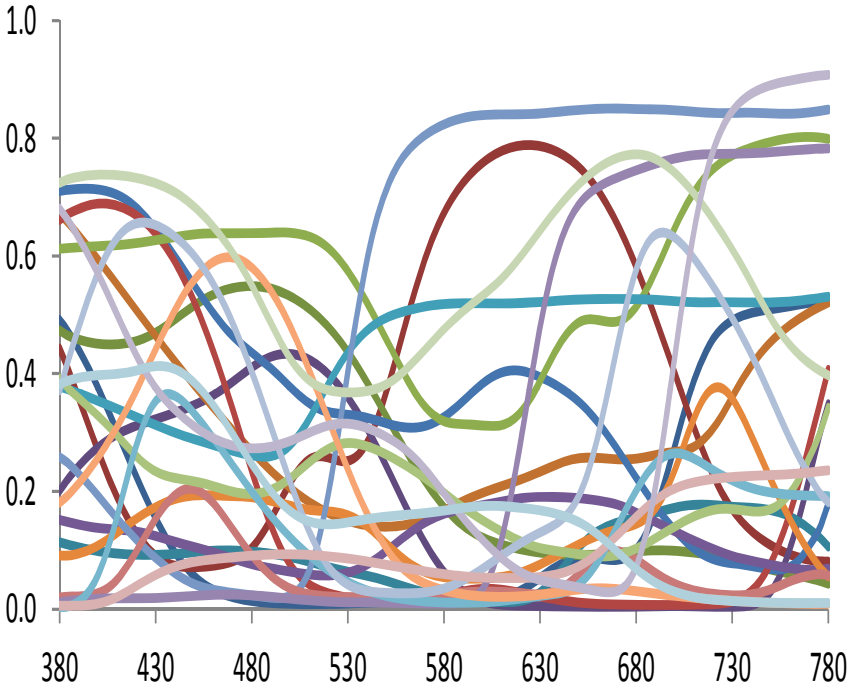
Average Curvature of the 8 CRI Samples



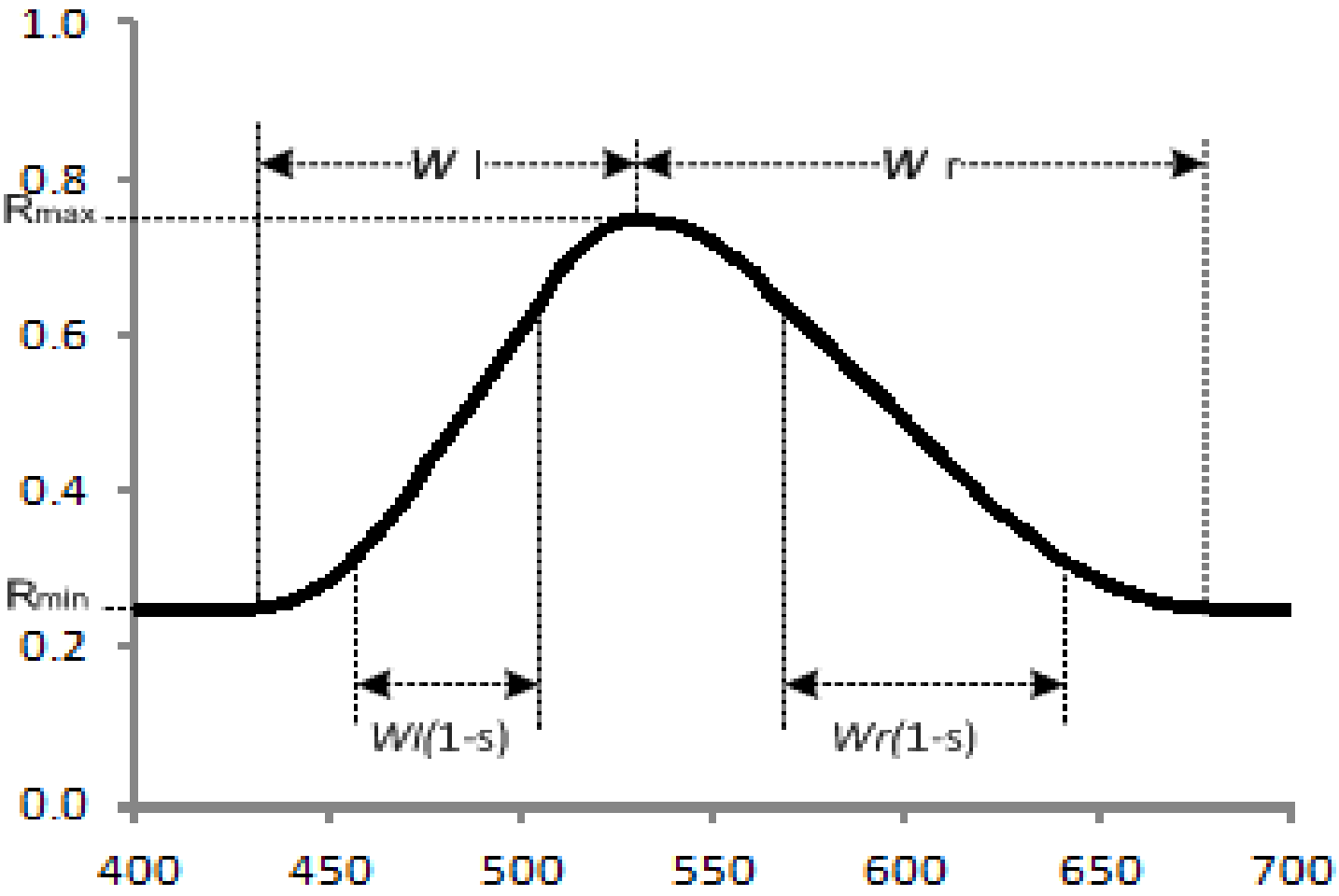
Average Curvature for 1000 Leeds Samples



Raw Spectra



Hybrid Spectra



Form of Representative Spectrum

i =1 to 17 $\quad l_{ci} = 550nm + 25nm * (i - 9)$

$M_i = 0.5 + 0.001nm^{-1} * (l_{ci} - 550nm)$

A) If ABS($l - l_{ci}$) ≥ [125nm] :

$R(l)$=[0.01]

B) If [125nm]>ABS($l - l_{ci}$)≥[75nm] :

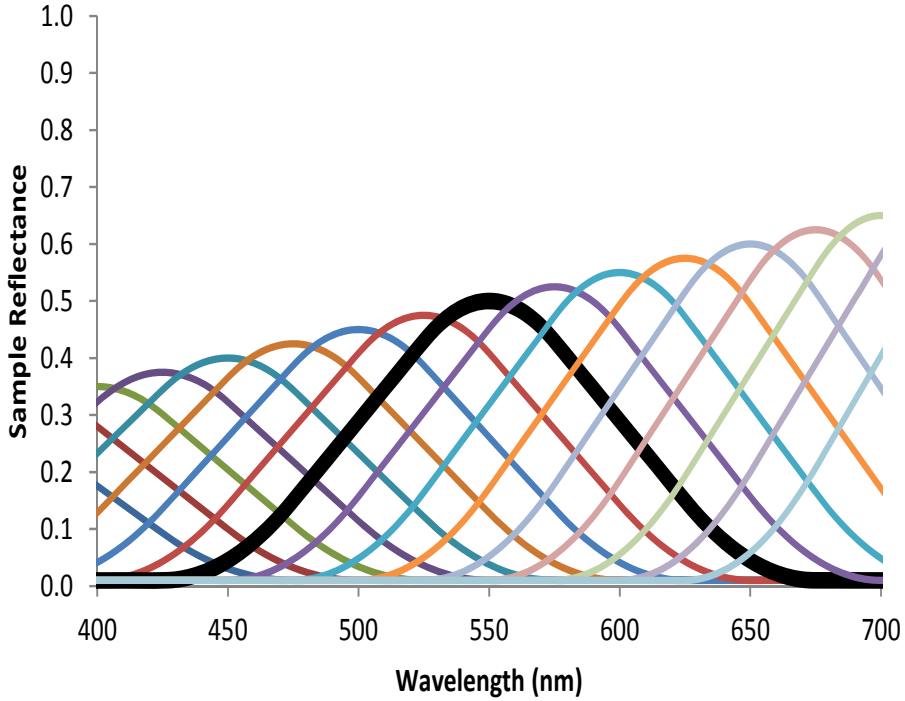
$$R(l)=[0.01]+(Mi-[0.01])*\left[\frac{1}{8750nm^2}\right] * \left([125nm] - ABS(\lambda - \lambda_{ci})\right)^2$$

C) If [75nm]>ABS($l - l_{ci}$)≥[25nm] :

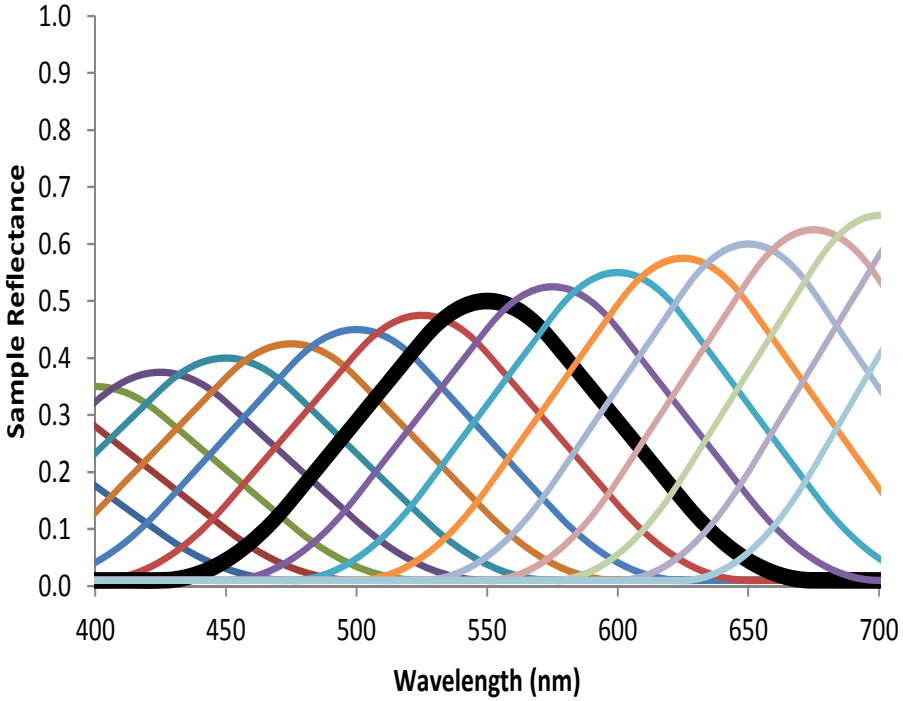
$$R(l)=[0.01]+(Mi-[0.01])*\left(\left[\frac{8}{7}\right] - \left[\frac{2}{175nm}\right] * ABS(\lambda - \lambda_{ci})\right)$$

D) If [25nm]>ABS($l - l_{ci}$) :

$$R(l)=[0.01]+(Mi-[0.01])*\left([1] - \left[\frac{1}{4375nm^2}\right] * (\lambda - \lambda_{ci})^2\right)$$



HL17 Spectral Set



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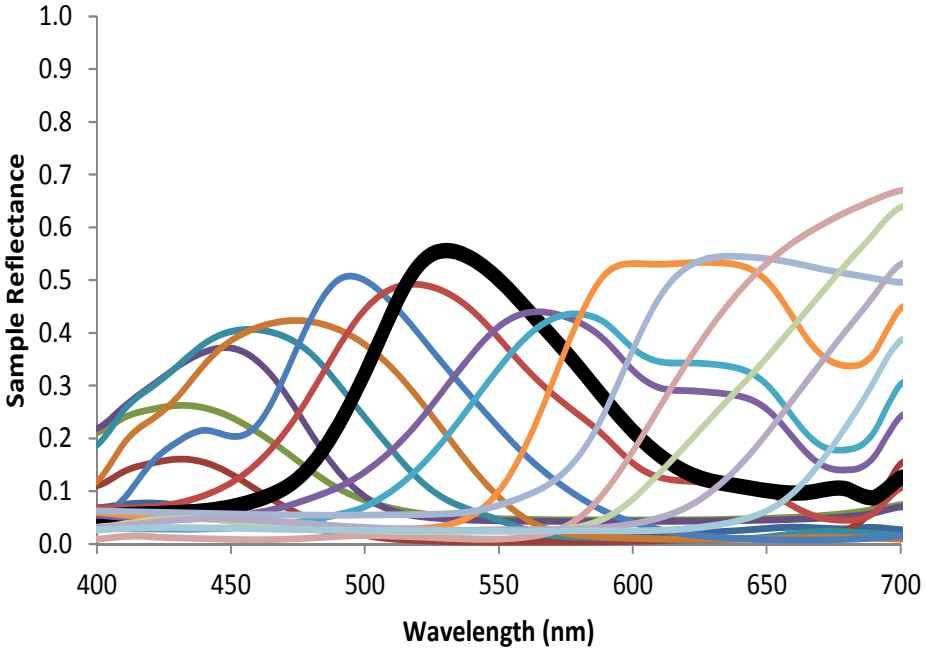
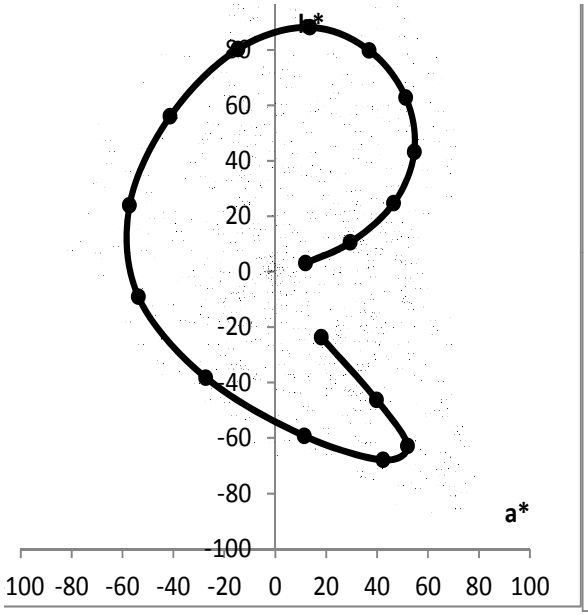
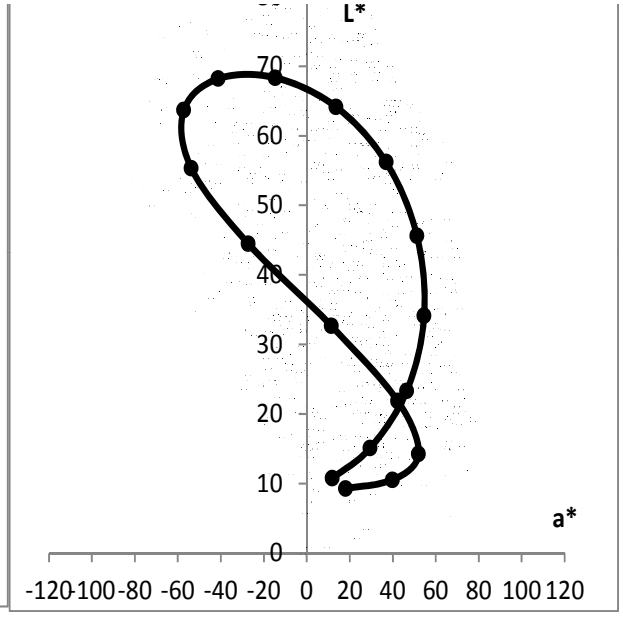


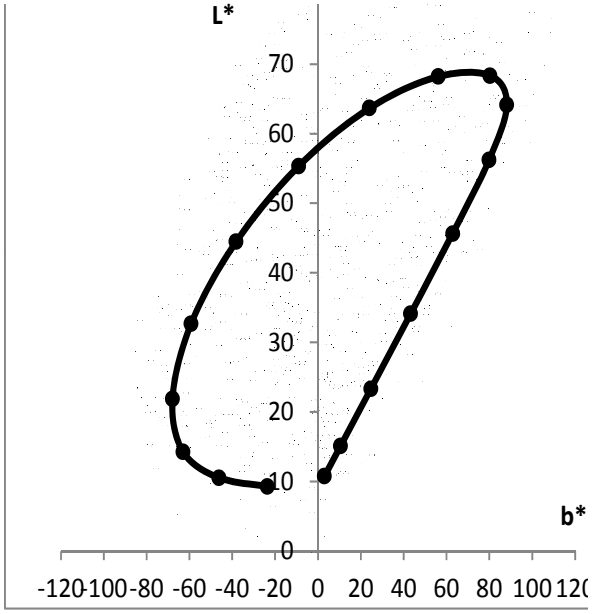
HL17 “Natural Matches”



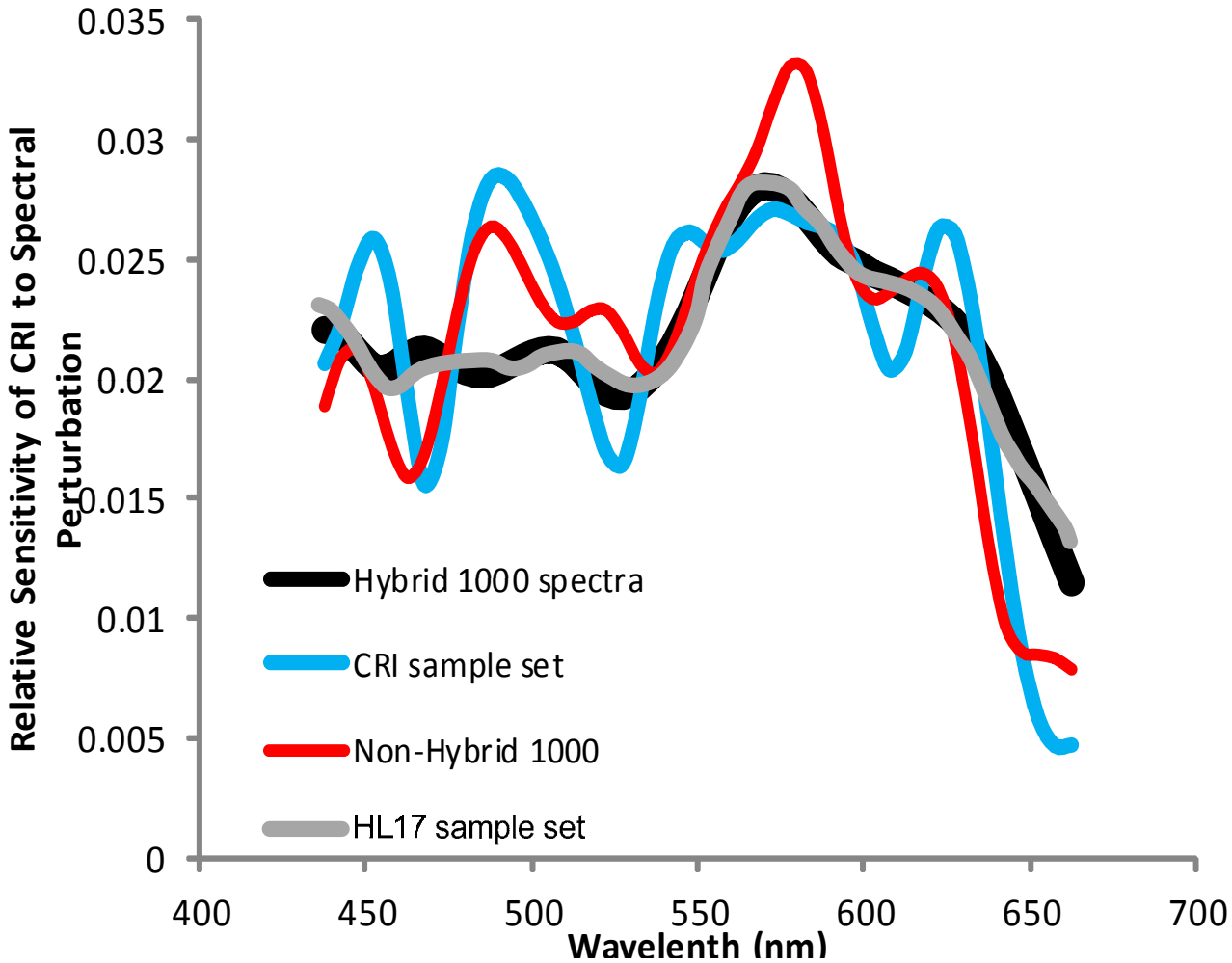
b vs. a**



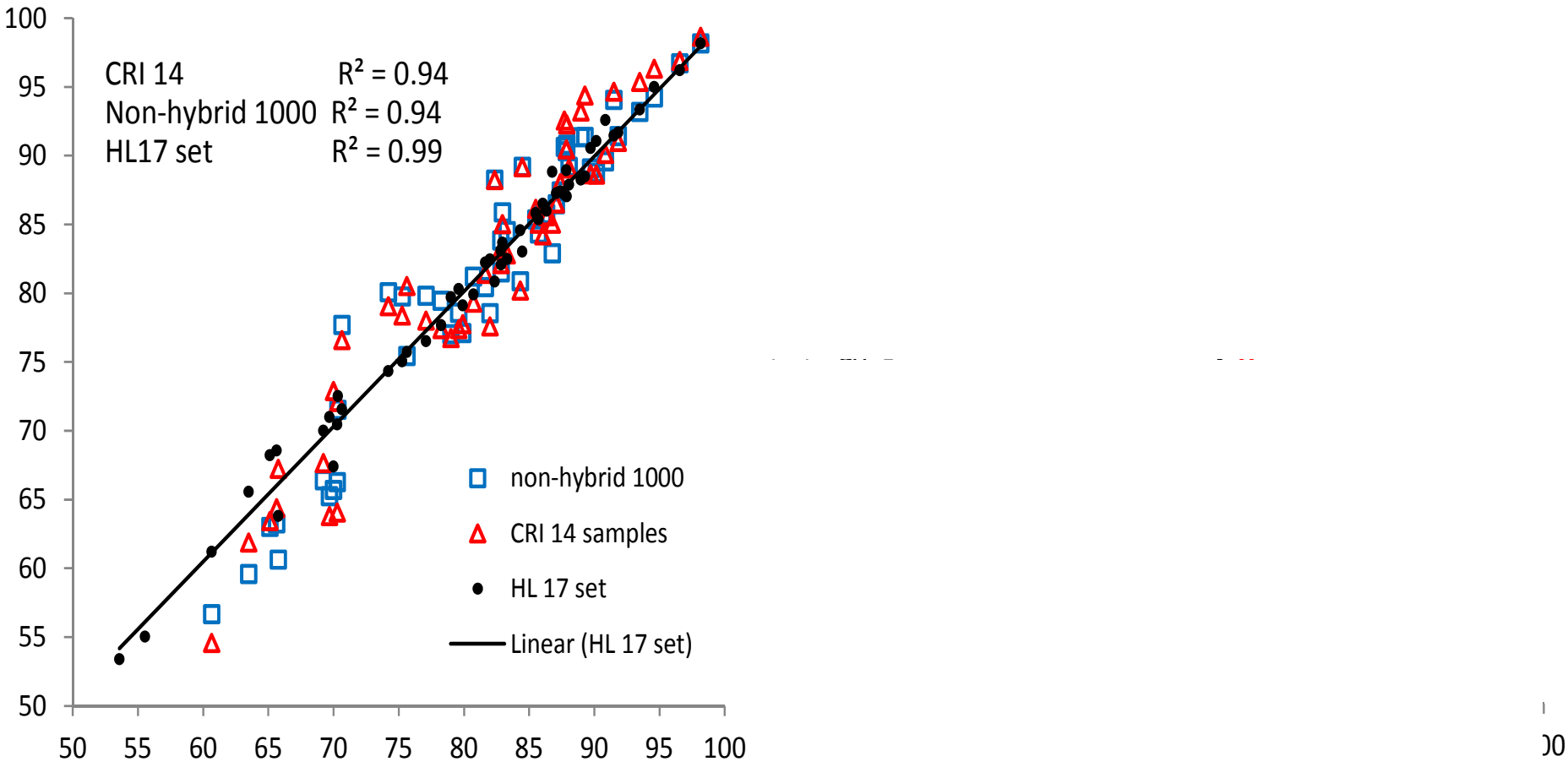
L vs. a**



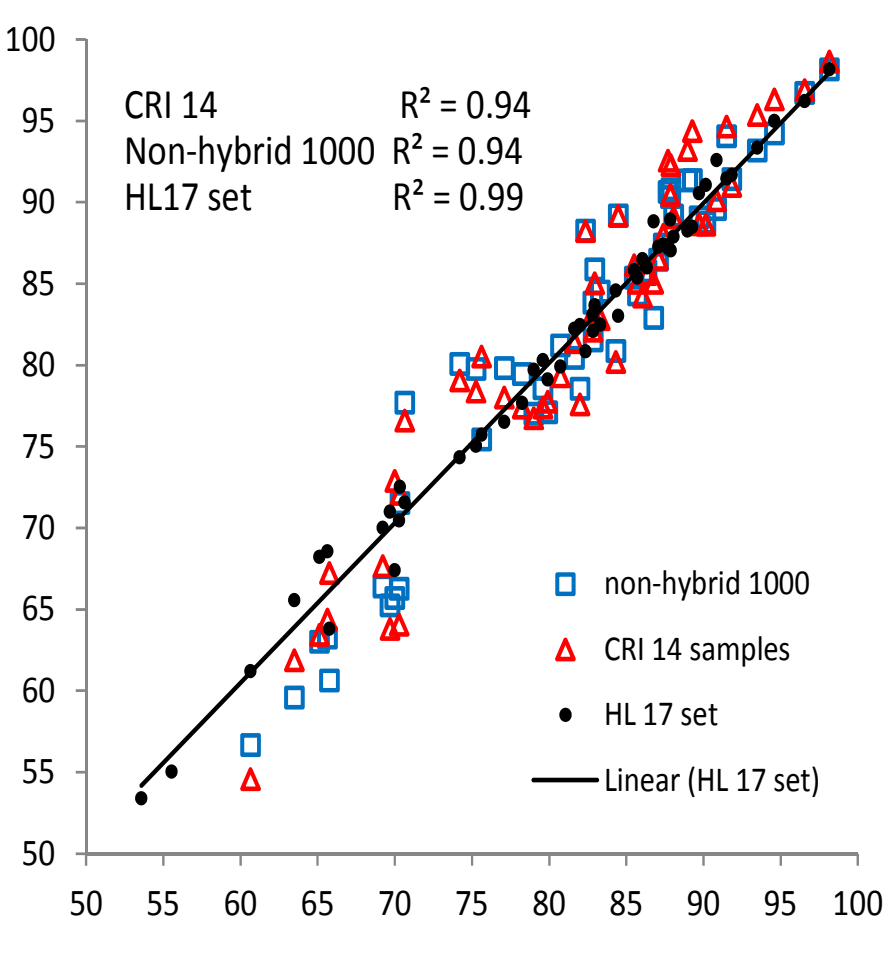
L vs. b**

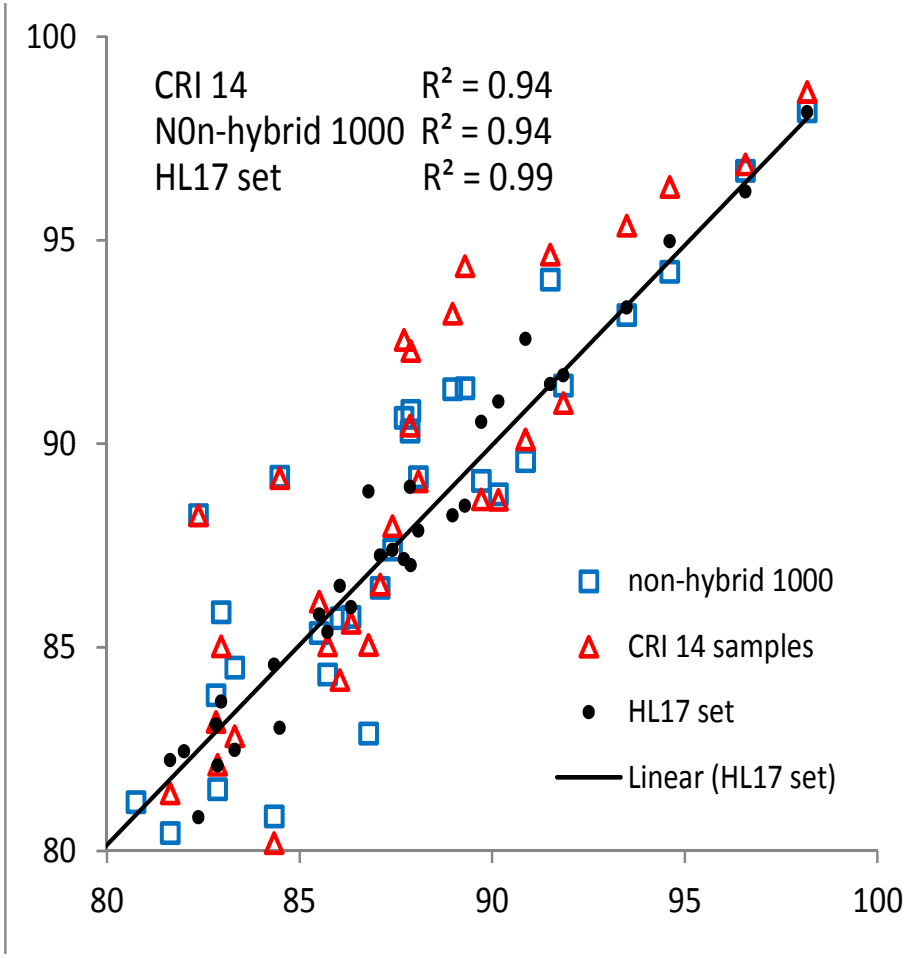


Sensitivity of CRI to Perturbations vs. Wavelength



CRI values compared to Hybrid Leeds Data





CRI values compared to Hybrid Leeds Data

Conclusions

- The HL17 set is proposed for CRI sample set
- This reduces CRI error from 5 points to <1
- The CRI will then work well with LEDs
- Work is still needed on color preference

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