Geometries and their significances – presented step by step

上海, 07NOV – 08NOV2011

Werner Rudolf Cramer
Introduction 介绍

Modern automotive paints contain three kinds of pigments:
现代汽车涂料包含三种颜料

- **Color pigments** absorb parts of the incident light and reflect the rest in all directions. 彩色颜料：吸收部分的入射光，并向四面八方反射剩余的光。

- **Aluminum pigments** mirroring the incident light and reflect it into one direction. 铝粉颜料：镜面反射入射光并将其在同一个方向上反射。

- **Interference pigments** reflect selectively the incident light. 干扰颜料：有选择性的反射入射光。
Introduction 介绍

The focus of the following considerations is on paint systems with aluminum and/or interference pigments. 下面主要讨论铝粉颜料和干扰颜料在涂料系统中的应用：

- The effects of these pigments - directed and selective reflection - are depending on the angles of illumination and observation. 这些颜料的反射效果-直接反射和选择性反射-都取决于光源和观察者的角度。

- Therefore you need exact information about the geometries. 因此了解观察者角度的信息必不可少。
The angle of 45° has been established as a „classical“ geometry of the illumination.

The corresponding gloss angle is -45°.

45°角被定义为经典的光源的照明角度。
与之相应的-45°被定义为与镜面反射角度。
Difference angles to the gloss angle are specified as observing angles. 相对于镜面反射的角度有其特定的观察的角度。
ASTM –standard practice 美国试验材料协会的标准惯例（American Society for Testing Material）


美国试验材料协会-标准E2539（对于干扰颜料的多角度颜色测量的标准惯例）确定了-15°逆镜像的观察角度
- Aspecular geometries
  -15°, 15°, 25°, 45°, 75° and 110°
  are provided by the BYK-mac.
- BYK-mac.可以测量-15°, 15°, 25°, 45°, 75° 和 110°不同角度的反射率。
- The distances between the geometries are 10° (15° - 25°), 20°, 30° and 35°.

观察角度之间的间距为10° (15° - 25°), 20°, 30° 和 35°.
Selection of geometries

• The selection of geometries is based partly on experiments and is partly determined arbitrarily. 观察角度的选择部分是基于实验的研究，部分基于人们的主观判断。

• Manufacturers of portable instruments have adopted these geometries.
  便携式仪器的生产商采用了这些观察角度。

• There are special models with selected geometries.
  选择观察角度时有许多特别的模型。
CIEL*a*b*

The following descriptions of a*b*-values are based on CIEL*a*b*:

- (+a*) = red axis ❄️
- (-a*) = green axis ❄️
- (+b*) = yellow axis ❄️
- (-b*) = blue axis ❄️
• The 110° geometry is widest away from gloss.
  110° 观察角是离镜面反射最远的观察角。
• The electrical signal is very low.
  电信号是非常弱的。
• This geometry is located below the illumination. With visual assessment this geometry is mostly taken at a wrong position.
  这个观察角的位置是在光源以下的，因此在这个角度视觉评价往往是在一个错误的位置。
The 110°-geometry has no significances in correlation with reflectance maxima. 110°-逆镜像观察角与反射率的最大值没有任何的关联关系。
A comparison of the lightnesses (left: aluminum, right interference samples) without 15°-geometry shows also small influence of the 110°-geometry.

在亮度的对比中（左：铝粉，右：干挠颜料）不含15°，观察显示110°的影响非常小。
75° aspecular 逆镜像观察角

- The results of the 75°-geometry differ usually only slightly from those of the 110°- geometry.

75°观察角度的观察结果和110°观察角度的观察结果只有很小的差异。

- The results clearly show the absorbing parts of the sample.

观察的结果非常清晰的表明样品吸收光的特性。
The 75°-measurement of this sample gives no indication of the effect. 75°观察角的测量并没有给出任何效果颜料的特性
45° aspecular 逆镜像观察角

- The 45°-geometry is a classical geometry for measuring. 45°观察角度是一个经典的测量观察角度。
- The position is consistent with the normal which is perpendicular to the sample. 这个观察位置与垂直观察样品的位置是一致的。
- The absorbing parts of the color shift are measured. 颜色变化的吸收光的特性在这一观察位置被测量到。
45° aspecular逆镜像观察角

• With 45° off gloss, this geometry is in the middle between illumination and gloss. 在离镜面反射45°的位置，这个观察角度介于光源和镜面反射的中央。

• Smaller aspecular geometries lie on the opposite side to the incident light. 小的逆镜像观察角度位于入射光的反向。
• The measurements at 45° indicates the absorbing parts.
45°观察角度的测量结果表明样品吸收光的特性。
• In this example, the results of all geometries are in two quadrants. The color shifts from greenish to reddish blue. 在这个样品中，所有的观察角度的测量结果都在两个象限中，颜色变化从带绿向的蓝色转变为带红向的蓝色。
• The 25°-geometry is a transitional geometry for interference pigments and their blends. 25° 观察角对干扰颜料和其混合颜料来说是一个过渡的观察角度。

• The geometry lies in the transistion zone between interference and absorption. 这个位于过渡带的观察角度正好介于干扰颜料与吸光颜料的区域之间。
25° aspecular

Between 20° and 30°, the interference color shifts from reflection to transmission color. 在20°和30°度之间，干扰颜料的颜色从反射色到传导色变化。
25° aspecular

Only at near gloss the interference color is observed and measured. At 25°, either the reflection or the transmission color is measured.

一般只在接近镜面反射的地方，才能测量和观察到干扰颜料的颜色。在25°的观察角度既测量到反射结果，也测量传导色的颜色。
15° aspecular 逆镜像观察角

<table>
<thead>
<tr>
<th>-15°</th>
<th>0°</th>
<th>15°</th>
<th>25°</th>
<th>45°</th>
<th>75°</th>
<th>110°</th>
</tr>
</thead>
</table>

- Interference pigments and thus the selective reflection is measured at 15° aspecular. 干扰颜料和选择性反射在15°观察角度被测量。
- Because of the small distance to gloss, measurements at 15° are very sensitive. 因为距离镜面反射的距离非常近，15°的观察结果非常敏感。
- Measurements nearer to gloss do not lead to physically plausible results. 接近镜面反射处测量不会带来任何物理上看似可信的结果。
15° aspecular 逆镜像观察角

The nearer to gloss you measure, the less plausible are the results. 越接近镜面反射的测量，测量结果的可信性越低。

Example of interference pigment blended with absorbing pigment. 例如干扰颜料和吸光颜料的混合物。
15° aspecular 逆镜像观察角

The nearer to gloss you measure, the bigger the differences of reflection maxima must increase. 越接近镜面反射观察角的测量结果，反射率曲线的最大值之间差异一定会增大。

Example: Interference pigment Xiralic Galaxy Blue
例如： Xiralic Galaxy Blue的干扰颜料。
The analysis of the results measured at -15° (trans-geometry) are related to those of +15° (cis-geometry). -15° (反式观察角）的测量结果的分析是与那些+15°(顺式观察角)的测量结果息息相关的。

Compared to white interference pigments and aluminum pigments, colored interference pigments behave differently to them. 对比白色的干扰颜料和铝粉颜料，彩色的干扰颜料的表现是不同。

These differences can be used for identification and characterization. 这些差异可以被用于做鉴定和确定不同颜料的特征。
Compared to the cis-measurement (+15°), the reflectance curves of colored interference pigments shift to shorter wavelengths.

与顺式测量+15°的测量结果的对比，彩色干扰颜料的反射率曲线的变化是在短的波长的范围内。
-15° aspecular

Example aluminum pigment:  例如  铝粉颜料
Reflectance curves shift to higher values.    反射率变化是转向更高的值。
The lightness L* at -15° is always higher than at +15°.

-15°的亮度值总会比+15°的亮度值偏高。

Mixtures of aluminum pigment with blue pigment.

铝粉颜料和蓝颜料的混合物。
The connection line between a*b*-values of +15° and -15° runs in the same direction as the lines of the other geometries.

在-15°和+15°之间a*b*值的连接线，与其它观察角度的连接线是向着相同方向延续的。
Colored interference pigments or mixtures thereof:
彩色干扰颜料或其混合物
Shifting to higher reflectance values and to shorter wavelengths.
在比较短的波长范围内反射率曲线的值的变化是很大的。
Even with colored interference pigments the lightness increases from +15° to -15°. 即使是彩色的干扰颜料，亮度也是从+15°到-15°增加的。
With colored interference pigments and mixtures thereof the line between +15° and -15° bends counter-clockwise in the a*b*-coordinate system.
Summary 总结

• Each of the six geometries has its own significance.
  这六个观察角每一个都有自己的特性。
• They have different weights and shares of colors and effects.
  它们对观察效果和颜色都有不同的比重和分配。
• With the new -15° geometry, effects can be better described and understood.
  对于新增加的 -15° 观察角度，效果颜料可以更好的被描述和解释。
• The combination of geometries at -15° and +15° can be used for proceeding analysis.
  结合-15° 和 +15° 的观察结果，可以被应用于生产过程的分析。
For measuring effects – aluminum and interference – geometries near to gloss are best.

对于测量效果颜料 – 铝粉和干扰颜料 – 观察角度越接近镜面反射的角度越好。
At geometries further off gloss mainly absorbing parts are measured. 远离镜面反射的观察角度，主要是测量物体表面吸收光的特性。
Thank you for your attention!