

## Q&A

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# QD Vision's Carlson And Coe-Sullivan Discuss Why Color Matters

**P**icture quality is key to any display. Pressure to improve color performance and accuracy, particularly in large formats, is driving innovation. To protect profit and remain competitive in the crowded consumer space, manufacturers and panel designers must close the color performance gap at the lowest possible cost of technology and integration. With these goals in mind, QD Vision and its chief officers Jason Carlson and Seth Coe-Sullivan deliver commercially viable quantum dot optical components that provide full-gamut color and cost savings for advanced display solutions.

**WONG:** Tell me about QD Vision.

**QD VISION:** QD Vision Inc. was founded in 2005 to advance the work of its cofounders and scientific advisors, including MIT professors Vladimir Bulovic and Mounji Bawendi, considered by many to be the father of quantum dot technology. Leveraging this rich set of intellectual assets, we developed QD Vision and our proprietary Color IQ technology (see the figure). Today, the company operates the world's largest quantum dot production facility and has the distinction, with the 2013 introduction of 10 production model Sony Bravia TVs, of being the

first to market with a commercially viable quantum dot technology solution in displays. Today, we hold over 50 patents in quantum dot materials, methods, and applications, with more than 200 patents pending.

**WONG:** Tell me about quantum dots and Color IQ.

**QD VISION:** Quantum dots are a semiconductor nanocrystal technology that precisely and efficiently emits light to provide full-gamut color performance and accuracy in LCDs. Color IQ optics, our brand of optical components, enables LCD TVs to produce very satu-

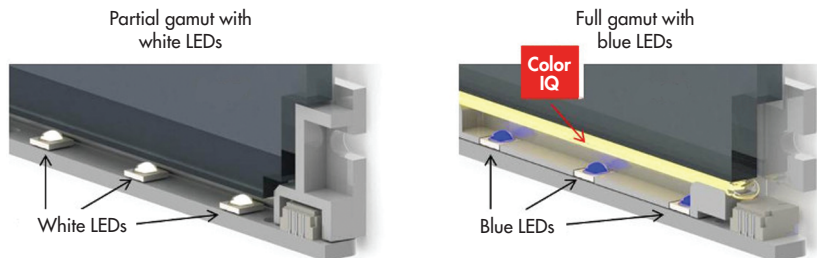
rated and narrow bands of color at any wavelength. While most LCD TVs and displays today offer color quality with a partial color gamut often ranging from 60% to 70% of the NTSC standard, products using Color IQ optical components can achieve 100% of the standard and beyond without compromising accuracy. The result provides the most radiant reds, brilliant blues, and gorgeous greens you will ever see.

**WONG:** How will quantum dots and Color IQ influence LCDs?

**QD VISION:** We believe that by improving LCD technology, Color IQ optics will help to extend LCD TV's lifetime in the market. Full-gamut color refers to the ability of an LCD device to display the widest range of colors available with 100% overlap of a color space as defined by the content creation community. Quantum dot-based solutions are not limited to the current gamut specifications and, in fact, can support color gamut well beyond what is available today. Because quantum dot materials are inherently efficient light emitters, they don't require the cost/performance tradeoffs typical of other materials and lighting technologies. These are just some of the reasons we believe that the adoption of quantum dot technology, Color IQ optics, and full-gamut color is inevitable for LCDs.

**WONG:** How does color affect image quality and viewer perception?

**QD VISION:** Research links the perception of quality with highly saturated



QD Vision's Color IQ technology replaces white LEDs with blue LEDs and adds a layer of quantum dots between the LEDs and the LCD.

colors, enabled by expanded color gamut, to both viewer attention (dwell time) and preference.

There is both a psychology and biology associated with color's role in the perception of picture quality. Humans are trichromatic, meaning we are tuned to distinguish a wide variety of wavelengths and hues of blue, green, and red. In the last 10 years, rigorous research has demonstrated that colorfulness is the main perceptual attribute underlying image quality.

For viewers, color accuracy is closely related to the perceived "naturalness" of an image, based on memory color and skin tone. Researchers have found that while the perception of quality rises with color saturation, it is only true up to the point at which skin tone starts to appear "unnatural."

**WONG:** Does increased color gamut indicate a tradeoff with color accuracy?

**QD VISION:** Not at all. In fact, full-gamut color is necessary to achieve both dimensions of viewer preference: colorfulness and color accuracy.

Video content creators define accuracy by agreeing on various color space dimensions within the total area of perceivable color. Thus, accuracy is the correct display of colors exactly as intended within a standard color gamut.

TV industry consultants and technicians calibrate and measure the degree to which a consumer device accurately displays colors within the area of a particular color-gamut standard. Examples include NTSC, Rec. 709, Adobe RGB, and DCI. These standards are important in that they give TV designers a metric of compliance to content creator choices.

The relationship between full color gamut and accuracy is an important distinction for quantum dot-based solutions. With Color IQ optics, the accuracy is not compromised as gamut is expanded.

**WONG:** Recent single-digit TV set market growth reports have put enormous pressure on LCD panel makers to reduce costs. So why would they invest in color-gamut expansion now?

**QD VISION:** To protect profit, it is imperative that panel designers close the color performance gap completely. The most compelling argument for immediate implementation of full-gamut color is the now established commercial viability of quantum

dot optical products. Quantum dots enable OLED-quality (organic LED) color at product costs well within the range of LCD TV retail pricing targets. Quantum dot optical products ship in volume today, delivering well-received full-gamut color in both television and tablet LCDs.

**WONG:** How is the full-gamut LCD market shaping up?

**QD VISION:** As with the transition from standard definition to HD, there are short-term gaps to address in content distribution standards, content availability, and the software layer to better support the new optical components' capabilities. But these challenges are readily addressable by several large-ecosystem communities that are incented to tackle them.

Content creation and processing equipment makers, as well as display suppliers, are anxious to offer consumers the next level of performance, bringing a cinema-quality viewing experience to mainstream, affordable home theaters. All of the ingredients are available to make full-gamut color display a reality. And like prior display technology transitions, including the transition to LEDs themselves, better consumer value will drive surprisingly rapid penetration. This is why QD Vision believes that full-gamut LCD TVs with quantum dot optics will achieve significant market penetration in 2014. 