

Notebook OLED Display



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Introduction

What is OLED

For two decades the flat panel display industry has been overwhelmed by LCD (liquid crystal display), and now the situation is about to change. OLED (organic light-emitting display) as a rising star is expected to be the next generation dominant in the display industry due to its many merits, it also has penetrated into smartwatches, smartphones, televisions, etc. And now, HP has overcome many technical challenges to officially bringing it to computer applications on laptops.

An OLED display has millions of pixels each consisting of red, green, and blue organic (carbon-based) light-emitting sub-pixel devices. Each organic light-emitting device is connected to its driving TFT (thin-film transistor) so it can be selectively turned on and off or alternate luminous level. The organic light-emitting device itself is made by special designed multiple functional organic semiconductor layers, sandwiched by two electrodes called anode and cathode. The driving TFT supplies current to the organic light-emitting device through the anode and organic layers and to the cathode. In this process, light would be generated in one of the organic layers called emissive layer. The color of light corresponds to the molecule properties of the emissive layer. And the intensity of light, or say the brightness, is related to the current applied.

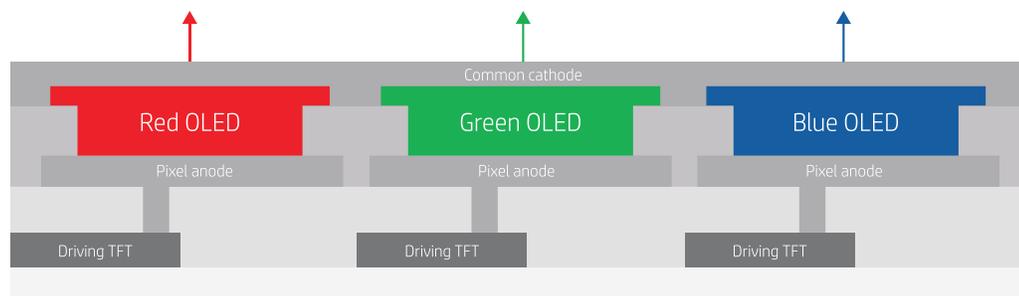


Figure 1. Structure of an OLED pixel including red, green, and blue devices.

Benefits of OLED

The mechanism of OLED is quite different to LCD. For example, OLED is a self-emissive device while LCD is not. As described above, each OLED sub-pixel is an individual lighting device that can be selectively controlled. On the contrary, LCD displays require a backlight unit to generate the white light. The liquid crystal and color filter layers block the unwanted intensity and color of light. This major difference results in many benefits of OLED where people can enjoy a much better visual performance. Some advantages of OLED are described below:

High contrast ratio. Because each sub-pixel can be individually controlled to emit light, when showing image with dark area, OLED panels can be completely dark without light leakage. The contrast ratio of OLED can reach 100,000:1 or higher, unlike the contrast ratio of LCD which is normally around 1,000:1. This feature is especially good when showing high contrast pictures, movies, or content with dark area.

Wide color gamut. OLED uses special designed organic materials to generate the red, green, and blue colors directly with less energy waste compared to the LCD which generally uses broad-spectrum white light as backlight and uses color filter to filter out the 3 essential colors. Currently our OLED can produce DCI-P3 100% in typical.

High brightness. The typical full brightness of our OLED panel is 400 nits when the screen is 100% white area and measured without a touch glass. Because OLED brightness is related to the current and loading effect, a higher current can be introduced to the specific OLED pixels to make it higher brightness (e.g. ~600 nits max) in local when the screen has smaller white area like 10%. This feature is specifically good when playing HDR content.

Wide viewing angle. LCD usually has contrast loss and color shift issue as well as the grey inversion at large viewing angles. OLED has less problems with these because it has a better viewing angle and contrast properties.

Fast response time. LCD response time is rather slow like few milliseconds (ms) to tens of milliseconds because the reactions of liquid crystal take time. OLED can immediately produce the light when current is applied with a response time of less than 1 millisecond. The result is OLED can exhibit less ghost imaging when playing high speed objects on the screen, such as gaming, movie, etc.

Low blue light. Although doctors are still studying deep blue light, which is close to UV light, that naturally exists in many conventional LCDs and might be harmful to human eyes under long time exposure. OLED, thanks to the special designed materials, the emissive spectrum of the blue is away from deep blue, so it is much less of a concern.

Technology Summary

HDR

In the real world, human eyes can see very wide range of colors and brightness. The high dynamic range (HDR) represents a higher range compared to the standard dynamic range (SDR) for image recording and reproducing, etc. Nowadays there are more and more movies and pictures that are made with HDR content, which means they come with information of wider range of colors and brightness than normal SDR content. A display that supports HDR content would be important to reproduce it. Our OLED display by nature has wide color space coverage of 100% DCI-P3 and high contrast ratio of 100,000:1, so it's very suitable to be the vehicle to reproduce the HDR content. It is also certified VESA DisplayHDR 400 True Black, which represents the high standard in the industry.

When watching media with HDR content, you may consider turning on Windows HDR mode by going to Settings > System > Display > Windows HD Color settings, and select the HDR toggle. Note that running the Windows HDR mode may consume higher system power and therefore sometimes the HDR toggle may be restricted because the laptop is not on AC power. It is recommended to turn off Windows HDR mode when you are not watching HDR content. Watching SDR content in Windows HDR mode would not add to the picture as SDR content does not include the metadata required.

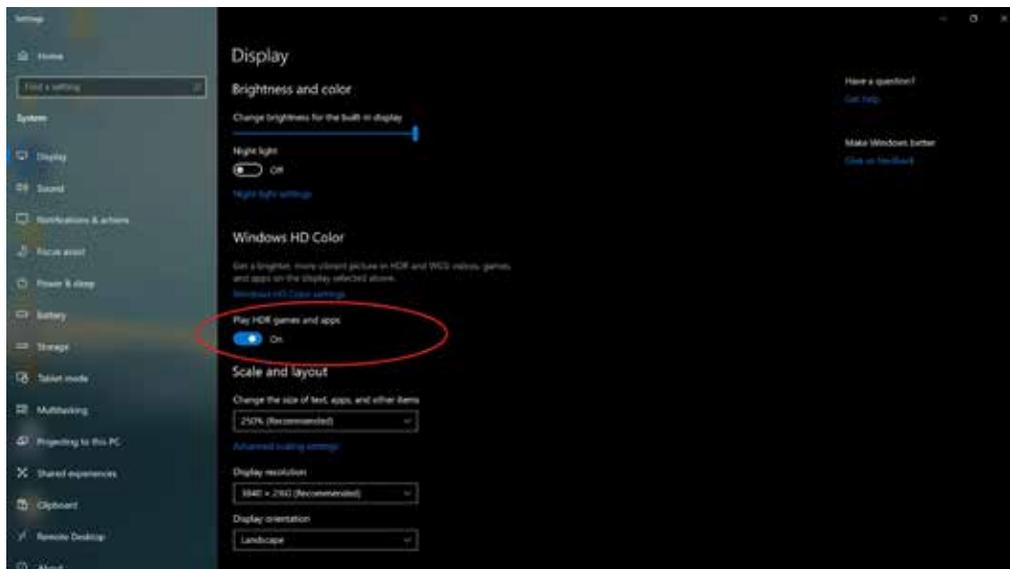


Figure 2. Turn on Windows HDR mode when playing HDR content.

Battery Life

Battery life in general will vary by platform and system configuration. The power consumption of the built-in display is of course one of the key factors impacting system battery life. And yet, the behaviors of power consumption of OLED displays differ to that of LCDs. The power consumption of LCD displays only vary with brightness, i.e., higher brightness leads to higher power consumption. The power consumption of OLED displays does not only vary with brightness but also the content displayed. There are a few tips below on how to lower the power consumption for OLED displays to save the system battery life.

Lower the brightness. When the organic light-emitting devices are boost to a higher brightness, it requires higher current and thus higher power. Therefore, lowering the brightness can greatly help system battery life. In fact, due to the high contrast of OLED displays, it looks brighter than other low contrast display like LCD under the same real brightness. Which means you can enjoy the nice performance of OLED display at lower brightness level.

Use dark mode. In OLED display, each pixel is an individual light emission device. When more pixels are on, or when more pixels are high brightness, all leads to higher power consumption. And vice versa, and therefore OLED power will vary with image content. When there is more white area with more pixels turned on to high brightness, the power is higher. And when more dark area with more pixels turned off or lower brightness, the power is lower. Windows has the options that allow user to switch between dark and light mode. It is suggested to use the dark mode to save OLED power and system battery life. In Windows 10, you may go to Settings > Personalization > Colors > and select “Dark” as default app mode. Many other applications like Microsoft Office also have similar options and need to be configured separately.

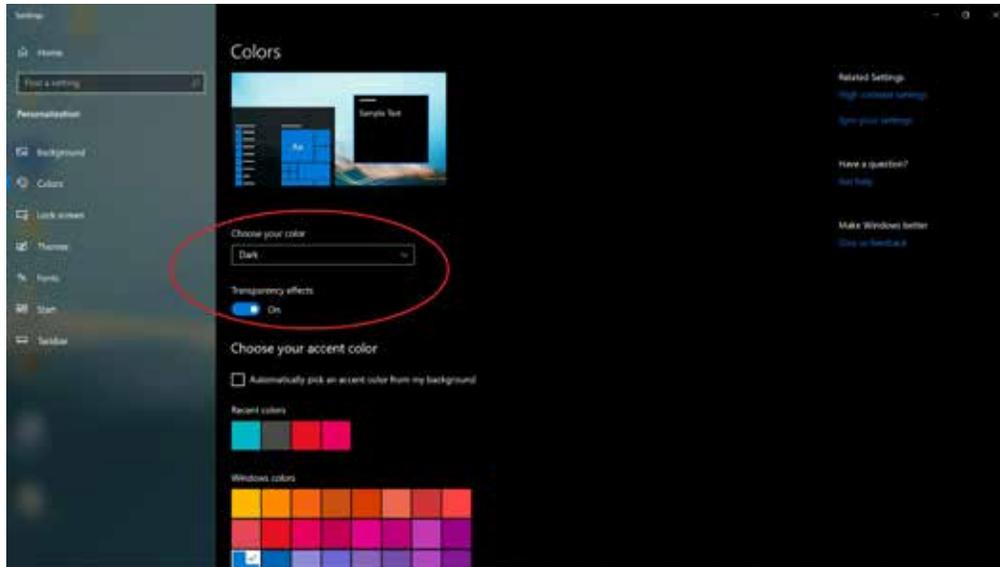


Figure 3. Set to dark theme in Windows.

Burn-In

“Burn-in” phenomena is a nature of displays with individual controllable light sources like OLED. This is because when a static image is played on the display for very long time, each pixel, as an individual light source, will decay differently. As a result, each pixel may have different luminous eventually, and look like the previous static image is burned into the screen permanently. HP has implemented the best of art including software and hardware solutions to minimize it. In most scenarios, the burn-in phenomena may not happen, or just very slightly which does not impact the visual performance. In some extreme scenarios, the burn-in could become worse and HP highlight recommends avoiding those scenarios. In addition to avoiding using the same static image on the screen for long period of times, here are a few tips that can help to reduce the risk of the burn-in:

Update to the latest HP drivers. The latest system drivers will help to run your system efficiently and correctly.

Auto-hide the taskbar. Conventionally the taskbar is always on the screen which has one of the highest risks for burn-in. Hiding the taskbar can significantly reduce the risk. To enable the taskbar autohide MS feature, you may go to Settings > Personalization > Taskbar > to enable the “automatically hide the taskbar” toggle.

Avoid highest brightness use for long time periods. Due to the high contrast of OLED, it looks higher perceived brightness for human eyes, so actually the need to use the highest brightness is very rare. Please adjust the brightness to a comfortable low level, in most of the usage.

Stay cool. Try to avoid using OLED displays in a high temperature environment or continuous use of the system at 100% load for a very long time.

Turn off the screen when you are not using it. To avoid static imaging when leaving on for a long time.

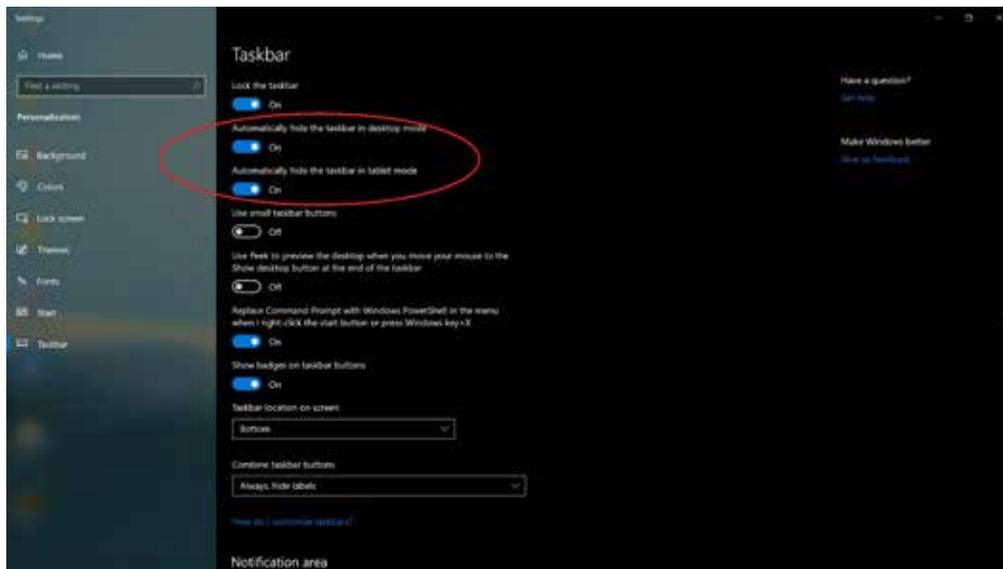


Figure 4. Set taskbar autohide.

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