

Scientific vs. Consumer Digital Cameras

One of the most common questions we are asked is: What is the advantage of a camera designed specifically for microscope use over a considerably less expensive consumer model? It basically comes down to quality of captured image and the reduction in effort required to obtain/save the images. Scientific cameras are a must if image analysis is planned because **all** the image pixel data is captured; they do not use software mapping to screen out bad pixels, 0 defect sensors are used for that purpose. Below are some of the advantages and disadvantages of each camera type.

Scientific Camera

Advantages:

- Real time viewing of the image (fast frame rate)
 - Provides accurate and fast focusing and color adjustment
- Uses dedicated video photo lenses for minimal chromatic aberrations and flattest field possible. It also provides the best match of microscope eyepiece field of view and actual captured field of view.
- Fast capture straight to the computer for immediate image analysis and manipulation.
- Most research models use specialized CCD sensors for:
 - Typically larger photo sites with deeper wells for greater light gathering
 - Maximum light sensitivity / low e noise
 - Uniform color across the field
 - Grade 0 sensors for NO bad pixel locations (important for image analysis)
- Range of sensor types for specific applications:
 - Monochrome for maximum sensitivity and spacial details
 - Available without IR block filter for non-visible light applications
- Models are available with **Peltier cooling devices** for maximum low-light performance
- Full camera control from on-screen Viewfinder:
 - Faster, easier learning curve
 - Accurate white balance controls (auto, manual, reference)
 - Control of SPOT metering...position exactly where needed and spot size best suited.
 - Ability to FRAME AVERAGE (for noise reduction) or FRAME INTEGRATE (for increased low light capture ability)
 - Ability to adjust input LEVELS for expanding contrast and maximize data acquisition
 - Pre-capture adjustment provides more post-capture adjustment possible
- Integrates with 3rd party analysis software (EMPIX, ImagePro, PhotoShop, etc) using custom drivers providing direct-to-application capture as well as TWAIN. Saves time and effort.
- TETHERED design so theft potential is greatly minimized. Cannot work as a standalone camera.
- Designed for long service life. Software upgradeable assuring your system will not become obsolete overnight and added capture features can be later added. We have been providing hundreds of scientific grade cameras for many years and have had very few (<1%) that needed to be repaired even after 5+ years of continuous use (Pixera). The repairs that were needed were performed at low cost.
- SDK's (software developers kit) available for specialized application integration by user

Disadvantages:

- Cost. Much greater than consumer but these are built for heavy use and abuse.
- Portability. Tethered so must be in the vicinity of the controlling PC.

Consumer Camera

Advantages:

- Low cost
- Portable

Disadvantages:

- Typically use CMOS technology for sensors. Inferior for low light microscopy applications (see CCD vs. CMOS)
- Have a built-in lense system. Even the best are a compromise of cost/performance specifically designed for the less demanding application of family photos.
- Requires costly specialized adapter lenses (typ >\$500) to connect to a microscope. The image must now go thru 2 sets of lenses (camera lenses and adapter lenses) before reaching the sensor resulting in chromatic aberrations and non-flat field
- User has minimal control over camera functions. Control access is more difficult due to multi-level menus, tiny control buttons, and small LCD display screens.
- Direct connection (if available) to a PC is typically slow so the screen refresh rate is low, making focusing and camera adjustments more difficult and time consuming.
- They use consumer grade sensors (even if they are CCD) so bad pixel locations are considered acceptable or mapped out in camera software. This becomes a major issue if the use of image analysis software is anticipated.
- Poor low light performance with limited spectral response. The cameras are designed to be used in typical consumer camera applications and mostly have filters to block non-visible light.
- Difficult or impossible to directly use with 3rd party image analysis software since they don't have native drivers available.
- Much more prone to THEFT. Chargers and accessories are always available elsewhere so having the camera body is all that is necessary.
- Models become obsoleted quickly so long term support is not assured. Since the manufacturer has moved on to the 'new' model, software upgrades and enhancements usually won't be available.

Summary

The scientific camera is a more rugged, user friendly way to capture and utilize images. Much less time and frustration will be spent in acquiring good images...TIME IS MONEY in business.

CCD vs. CMOS CAMERA SENSORS

CCD:

Strengths

- Highest image quality
- Lowest noise factor
- Better output uniformity
- Superior quantum efficiency and noise performance
- ALL of the pixel surface area can be devoted to light capture
- Excellent low light capture (highest sensitivity)

Weaknesses

- More costly to manufacture
- Require off-chip support circuits for sensor conversion

CMOS:

Strengths

- Lower cost to manufacture
- Usually have support circuits on-chip for each pixel:
 - But at the expense of reduced pixel surface area for capture
- Requires less 'off-chip' circuitry

Weaknesses

- Poor low light performance (especially critical issue for microscopy)
- Poorer image uniformity of light since each pixel has its own charge to voltage converter.
- Higher noise factor (especially critical in fluorescence applications)
- Requires an on-chip 'microlense' to increase pixel well fill since some of surface area is used by conversion circuitry