

2 mm

ILLUMINATION (LIGHTING) SYSTEMS FOR STEREO MICROSCOPES

Obtaining the Best Results for Industrial Applications

Introduction

This report gives users of stereo microscopes helpful advice when attempting to select optimal illumination or lighting systems for sample observation.

The illumination used for microscopic observation has a very important effect on the final image quality. Choosing the illumination to achieve the best results depends upon the type of sample and its features of interest, as well as the application and purpose for microscopic observation [1, 2, 3, 4].

The following information should help microscope users to choose illumination systems that produce the best imaging results.

Advantages of LED (Light-Emitting Diode) Illumination

LED microscope illumination technology provides several advantages for microscopy imaging when compared to commonly used halogen lights. These advantages are

- > Longer lifetimes (25,000 to 50,000 hours)
- > Lower power consumption
- > Natural color temperature
- > A “cold light” source → less heat release (useful for temperature-sensitive samples)
- > A practical compact design
- > Constant color temperature even at low brightness levels.

Key Factors for the Choice of Illumination

There are several important factors to consider for high quality microscopic observation and imaging of a sample when selecting the proper type of illumination:

- > Which types of samples are to be observed?
- > Which features of the samples are to be analyzed?
- > Which difficulties are noticed with currently used types of illumination?
- > Is there a need to access the sample during microscopic observation, e.g., manipulation with scalpel, tweezers, soldering iron, or other tools?

Microscope users may have to try multiple types of illumination in order to find the optimal lighting [5, 6]. Users can arrange for a demonstration of various illumination systems with a sales representative from Leica Microsystems or an authorized dealer before deciding which one to buy.

The Leica LED5000 series illumination systems are mainly used for higher performance stereo microscopes, e.g., Leica M125, M165, or M205 [7]. The Leica LED3000 series systems are mainly used for routine stereo microscopes, e.g., Leica S4, S6, S8 APO, M50, M60, or M80 [7]. Some basic information about the Leica LED5000 and LED3000 series are shown below.

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Overview of LED (Light-Emitting Diode) Illumination Systems

Ring light (RL) gives bright and uniform illumination of the sample; suitable for many types of samples. Additionally, diffusors and polarized light sets are available for both ring light types. These accessories reduce the problems of glare and highlighting of spots.



Coaxial illumination (CXI), where the beam of light is guided through the optics and reflected from the sample, works best for smooth and reflective samples. It is especially useful if fine cracks or surface quality must be assessed.



Near vertical illumination (NVI), achieved with LEDs positioned very close to the optical axis, provides nearly shadow-free lighting and is practical for samples with recesses and deep holes or those that require long working distances.



Spotlight illumination (SLI) with flexible goosenecks offers high contrast lighting suitable for many types of samples.



Diffuse and highly diffuse illumination (DI and HDI) are designed for highly reflective, non-flat or curved samples that are difficult to image due to the amount of back-reflected light.



Multi-contrast illumination (MCI), utilizing repeatable contrast with lighting from 2 different directions and angles, is useful for samples with hard-to-find details.



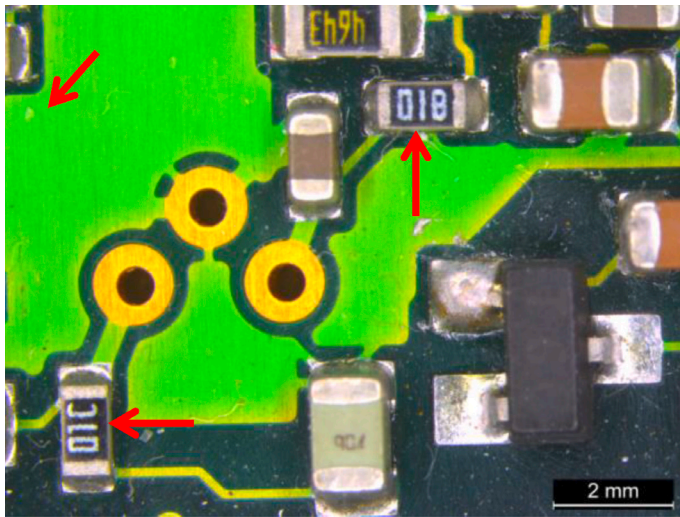
Back light illumination (BLI) provides transmitted lighting for transparent samples.



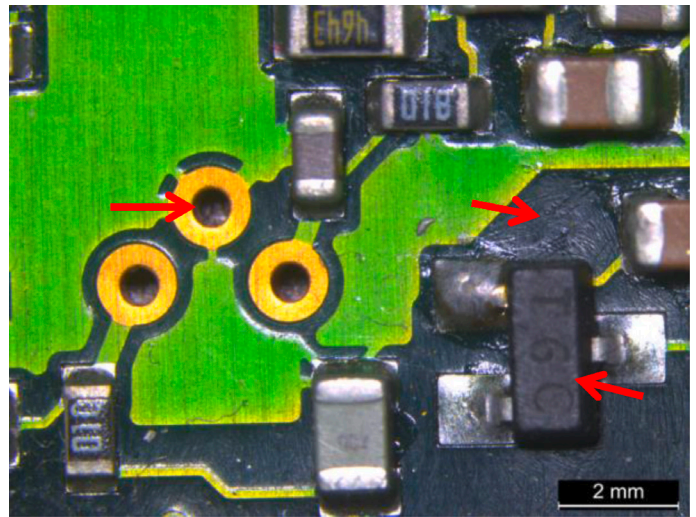
Results with Leica LED5000 and LED3000 illumination

Example images of various samples are shown below. The images were recorded with a Leica M165 stereo microscope equipped with a Leica DFC495 digital camera and a LED3000 or LED5000 series illumination system.

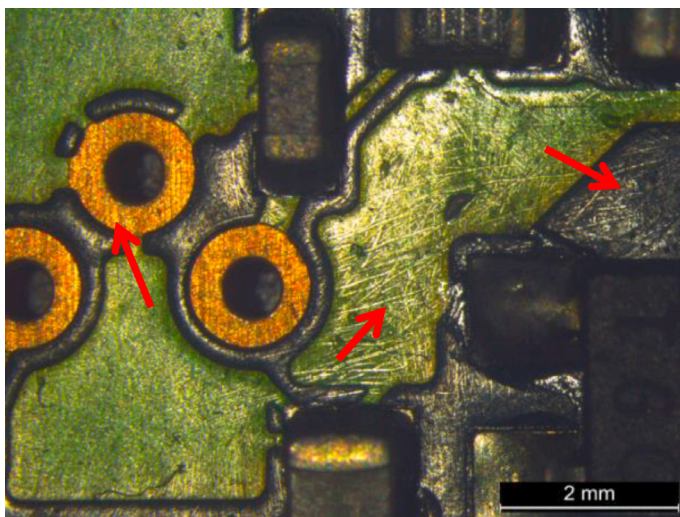
Sample: Printed Circuit Board (PCB)



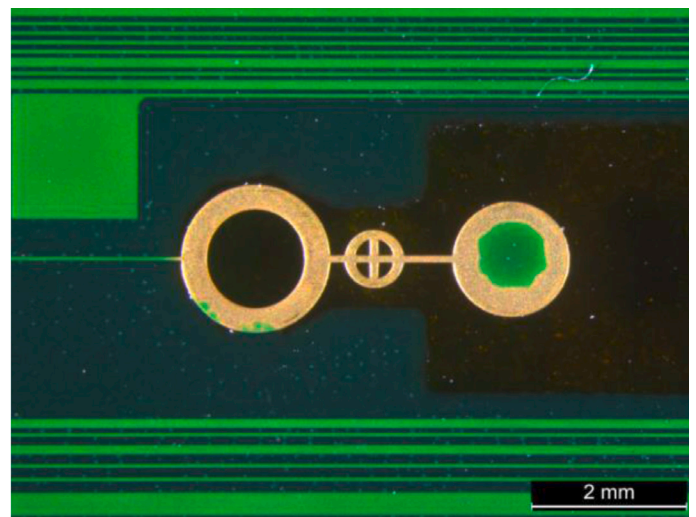
Ring Light Illumination (RL): multiple sample features



Near Vertical Illumination (NVI): holes and recesses

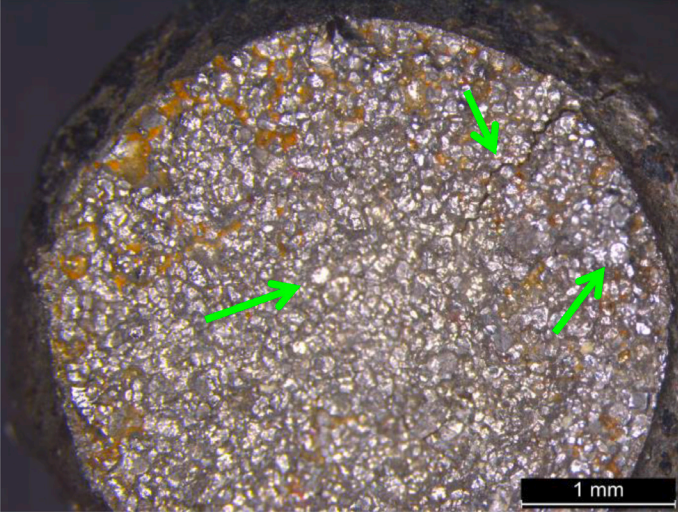


Coaxial Illumination (CXI): scratches and surface texture

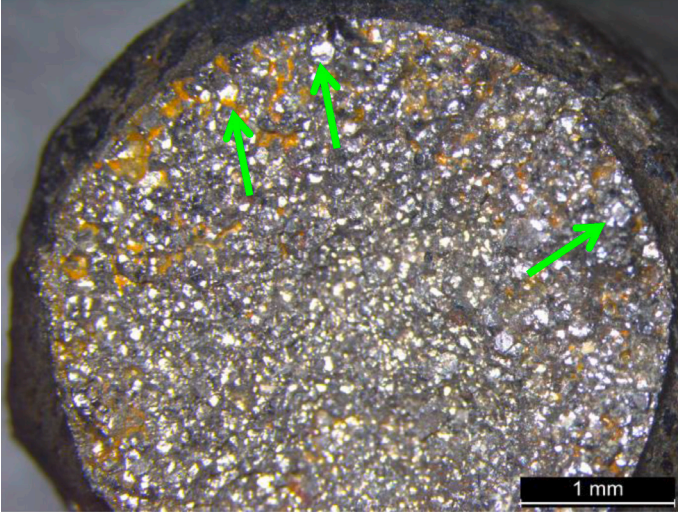


Spotlight Illumination (SLI): multiple sample features

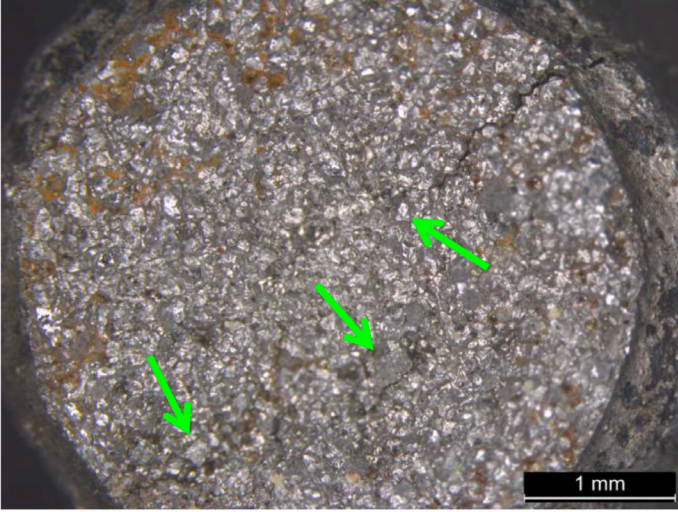
Sample: Hip Implant Part



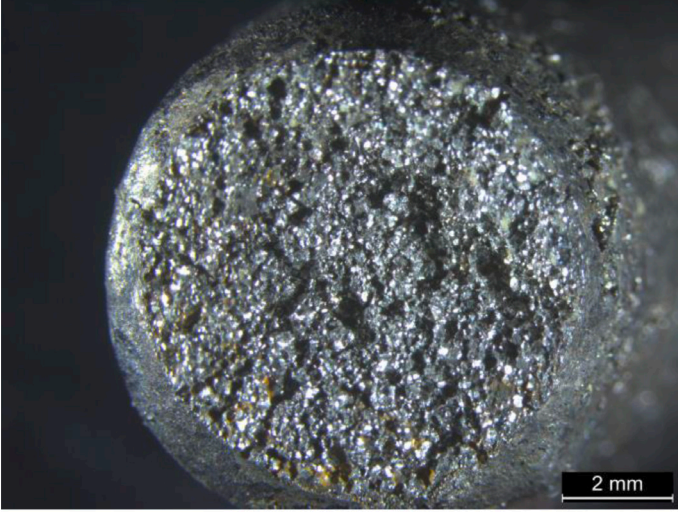
Ring Light Illumination (RL): multiple sample features



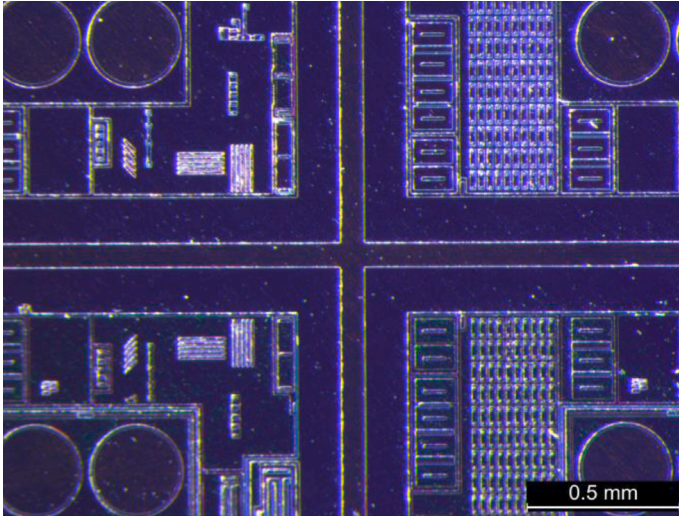
Near Vertical Illumination (NVI): holes & recesses



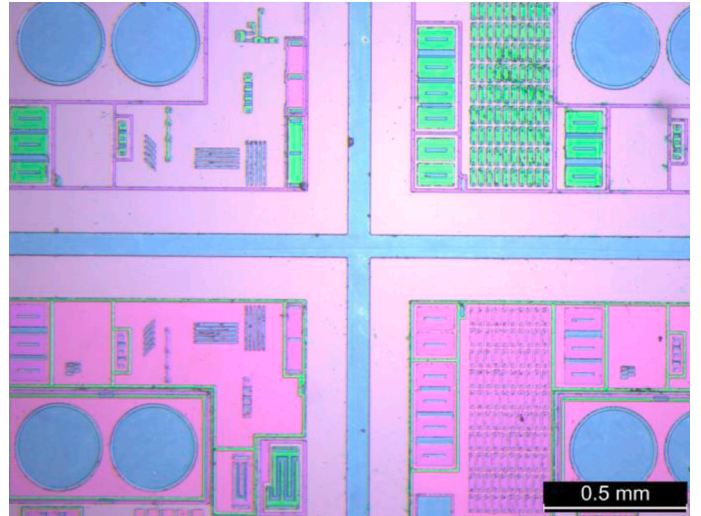
Highly Diffuse Illumination (HDI): reflective areas



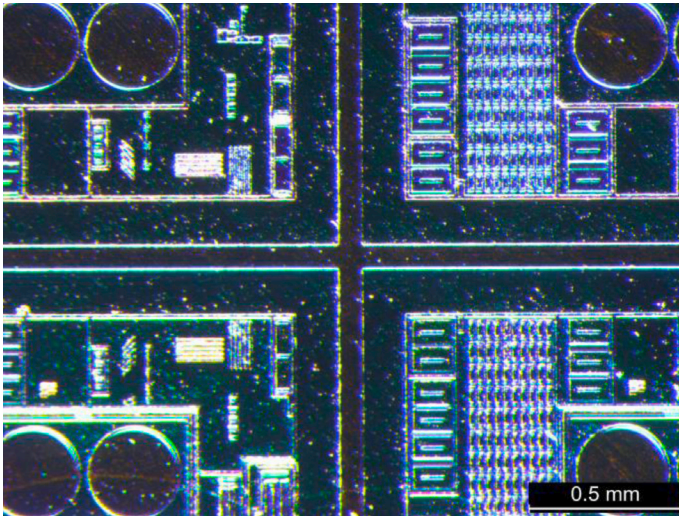
Spotlight Illumination (SLI): multiple sample features

Sample: Microelectronics

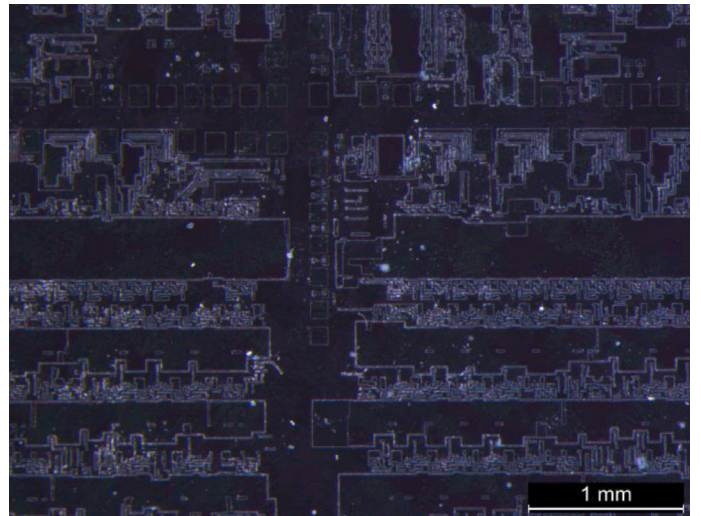
Ring Light Illumination (RL): multiple sample features



Coaxial Illumination (CXI): surface texture



Near Vertical Illumination (NVI): holes and recesses



Highly Diffuse Illumination (HDI): reflective areas

Other Recommendations

In addition to the high-quality optics used by microscopes from Leica Microsystems, it is important to identify the sample features to be analyzed and the field of view, i.e. the object field, required for observation when selecting an illumination system. It is also worthwhile to consider the advantages of computer encoding and the proper microscope optical performance, i.e., objective lenses, which can be plan, planapochromatic, achromatic, etc.

Keep in mind that there are additional considerations for illumination:

- > For the required optical performance, certain illumination systems may not be compatible, e.g., the Leica LED5000 RL illumination system cannot be used with a 2.0x objective lens
- > Always consider alternative illumination systems, such as a Leica LED spotlight (SLI) with gooseneck system, instead of a Leica LED ring light (RL) when using stereo microscopes with objective nosepieces or microscope configurations with small working distances.

Conclusion

Finding the best illumination system for samples observed by a stereo microscope is not always simple. However, the advice and recommendations mentioned in this report can aid users when investigating various illumination systems to find the ones which give the best imaging results for stereo microscope observation and image recording.



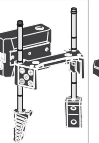


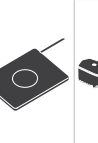
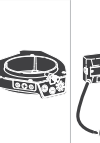

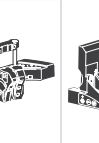
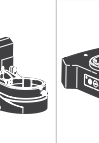
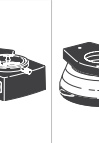

On the following page, you will find the quick selection guide for the Leica LED3000 and LED5000 series of illumination systems. This guide can be very helpful for microscope users attempting to find the most appropriate illumination systems for particular samples and applications.

References / Additional Reading



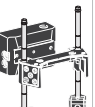

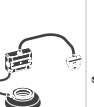
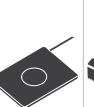





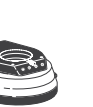
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7. Goeggel, D.: *Factors to Consider When Selecting a Stereo Microscope*. Science Lab.

QUICK SELECTION GUIDE

for Leica LED3000 / LED5000

Name of illumination	LED3000						LED5000					
	LED3000 RL Ring light	LED3000 SLI Spotlight	LED3000 MCI Multi-contrast	LED3000 NVI Near vertical	LED3000 DI Diffuse	LED3000 BLI Back light	LED5000 RL Ring light	LED5000 SLI Spotlight	LED5000 MCI Multi-contrast	LED5000 NVI Near vertical	LED5000 CXI Coaxial	LED5000 HDI Highly diffuse
Picture												
Order code	10450271	10450508	10450507	10450657	10450660	10450661	10450494	10450548	10450561	10450658 10450659	10450656	10450062
Sample characteristic/Application												
Flat sample	●	◐	○	○	◐	● transparent	●	◐	○	◐	◐	●
Flat polished sample	–	–	–	–	–	–	–	–	–	–	●	–
Structured surface / profile	◐	◐	●	–	●	–	◐	◐	●	◐	–	●
Shiny surfaces	◐ ¹⁾	○	◐	○	●	–	◐ ¹⁾	○	◐	● ¹⁾	◐	●
Metallic surfaces	◐ ¹⁾	○	◐	○	●	–	◐ ¹⁾	○	◐	● ¹⁾	◐	●
Scratch	◐	◐	●	–	○	–	◐	◐	●	◐	◐	○
Recess	◐	◐	●	–	○	–	◐	◐	●	–	◐	○
Bore holes / holes	○	○	–	●	–	–	○	○	–	●	●	–
Reflective surfaces (e.g. mirror)	◐ ¹⁾	○	○	○	○	–	◐ ¹⁾	○	○	○	● ¹⁾	○
Translucent samples	– ²⁾	– ²⁾	– ²⁾	–	–	●	–	–	–	–	–	–
Transparent samples	– ²⁾	– ²⁾	– ²⁾	–	–	●	–	–	–	–	–	–
Illumination characteristic												
Shadowfree illumination (homogenous)	◐	○	○	–	●	●	◐	○	○	–	–	●
Bright illumination	●	●	◐	◐	◐	◐	●	●	◐	●	◐	●
Large object field	●	○	◐	○	●	◐	●	○	◐	◐	○	●
High contrast illumination	◐	●	●	○	○	○	◐	●	●	◐	○	○
Working distance												
– short (< 50 mm)	○	●	◐	○	●	●	○	●	◐	●	◐	◐
– mid (50–100 mm)	●	●	●	●	●	●	●	●	●	●	●	●
– mid (100–150 mm)	●	●	●	●	●	●	◐	●	●	●	○	○
– long (> 150 mm)	○	●	◐	●	◐	●	○	●	●	●	○	○
Different segments of lighting	●	◐	●	–	–	–	●	◐	●	–	–	◐
Reproducible settings	● ³⁾	–	–	● ³⁾	●	◐ ³⁾	● ³⁾	–	◐ ³⁾	● ³⁾	● ³⁾	● ³⁾
Repeatable contrast	● ³⁾	–	◐ ³⁾	● ³⁾	●	–	● ³⁾	–	◐ ³⁾	◐ ³⁾	◐ ³⁾	● ³⁾
Easy moving of sample	●	●	●	●	◐	●	●	●	●	●	●	○
Perpendicular lighting	–	○	–	–	–	◐	–	○	–	–	●	–
Flexible positioning of illumination	–	●	◐	–	●	○	–	●	●	–	–	–

● = ideal; ◐ = good; ○ = not ideal; – = not possible; 1) with diffusor to reduce reflections, with polarization set to minimize reflections; 2) possible with dedicated transmitted light bases (TL bases); 3) in combination with Leica Application Suite (LAS) software

Name of illumination	LED3000						LED5000					
	LED3000 RL Ring light	LED3000 SLI Spotlight	LED3000 MCI Multi-contrast	LED3000 NVI Near vertical	LED3000 DI Diffuse	LED3000 BLI Back light	LED5000 RL Ring light	LED5000 SLI Spotlight	LED5000 MCI Multi-contrast	LED5000 NVI Near vertical	LED5000 CXI Coaxial	LED5000 HDI Highly diffuse
Picture												
Order code	10450271	10450508	10450507	10450657	10450660	10450661	10450494	10450548	10450561	10450658 10450659	10450656	10450062
Microscope combinations												
S4 / S6 / S6 E / S8 APO	●	●	●	●	●	●	–	–	–	–	–	–
M50 / M50 / M80	●	●	●	●	●	●	–	●	–	● ⁴⁾	●	–
M125	–	–	–	–	–	–	●	●	●	●	●	●
M165 C	–	–	–	–	–	–	●	●	●	●	●	●
M165 FC	–	–	–	–	–	–	●	●	●	–	–	●
M205 A	–	–	–	–	–	–	●	●	●	●	●	●
M205 C	–	–	–	–	–	–	●	●	●	●	●	●
M205 FA	–	–	–	–	–	–	●	●	●	–	–	●
Z6 / Z16 / Z6 APO / Z16 APO	●	●	●	●	●	●	–	●	–	–	–	–
DMS300 / DMS1000	●	●	●	●	●	●	–	●	–	● ⁴⁾	–	–
Technical data/ specification												
SmartTouch-connectivity	●	●	–	●	●	●	●	●	●	●	●	●
Leica Application Suite-control	●	●	–	●	●	●	●	●	●	●	●	●
Type of illumination												
– LED	●	●	●	●	●	●	●	●	●	●	●	●
– Halogen	–	–	–	–	–	–	–	–	–	–	–	–
Recomm. working distance (mm)	60–150	–	–	60–150	50–200	–	50–80	–	–	5–400	–	60–70
No. of LEDs (TL)	24	2	4	2	36	36	40	2	9	2	2	132
No. of brightness levels	10	10	10	10	10	10	10	10	10	10	10	10
No of illumination scenarios	9	3	9	1	1	1	19	3	5	1	1	3
CAN bus / CTL2	●	●	●	●	●	●	●	●	●	●	●	●
LED service life (hours) (50% of intensity)	50,000	50,000	50,000	50,000	30,000	30,000	50,000	50,000	50,000	50,000	50,000	30,000
Color temperature (K)	5,600	5,600	5,700	5,600	6,000	6,000	5,600	5,600	5,700	5,600	6,200	6,500
Compatibility with FusionOptics	–	–	–	–	–	●	●	●	●	●	●	●
Power supply induced	–	–	–	–	–	–	–	–	–	–	–	–
Power consumption (W)	15	5	10	10	10	10	10	5	15	15	10	25
Control panel on gooseneck	–	●	–	–	●	–	–	●	–	–	–	–
Built-in control panel	●	–	●	●	–	●	●	–	●	●	●	●
Inner diameter / objective size (mm)	58	–	–	58	–	–	80	–	–	65	–	80

● = ideal; ◐ = good; ○ = not ideal; – = not possible; 4) with achromat, 65 mm diameter objective (MD objective)

The statement by Ernst Leitz in 1907, *“With the User, For the User,”* describes the fruitful collaboration with end users and driving force of innovation at Leica Microsystems. We have developed five brand values to live up to this tradition: Pioneering, High-end Quality, Team Spirit, Dedication to Science, and Continuous Improvement. For us, living up to these values means: **Living up to Life.**

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