Imaging Technical Note

Zeiss AxioCam and Adapter Comparison

Four of Zeiss's most-used AxioCam cameras and adapters were compared:

Cameras Tested
- AxioCam 105 color
- AxioCam 305 color
- AxioCam 503 color
- AxioCam 506 color

Adapters Tested
- 0.5X camera adapter
- 0.63X camera adapter
- 1X adapter

Parameters
- AxioImager A2m™ Upright Microscope
- EC Epiplan-Neofluar 10X objective
- Brightfield
- Full resolution of each camera (no binning)
- Cast Iron Sample

Figure 1: AxioCam digital cameras

The contrast differences between the cameras are slight, but still detectable, especially on the full-resolution images (zoom in on the images using the zoom function on the .pdf reader). This can be attributed to the camera sensors' different dynamic ranges and sensitivities, with AxioCam 506 color having the best color reproduction compared to looking through the eyepieces. The other difference is the field of view available with each camera (Figure 3).

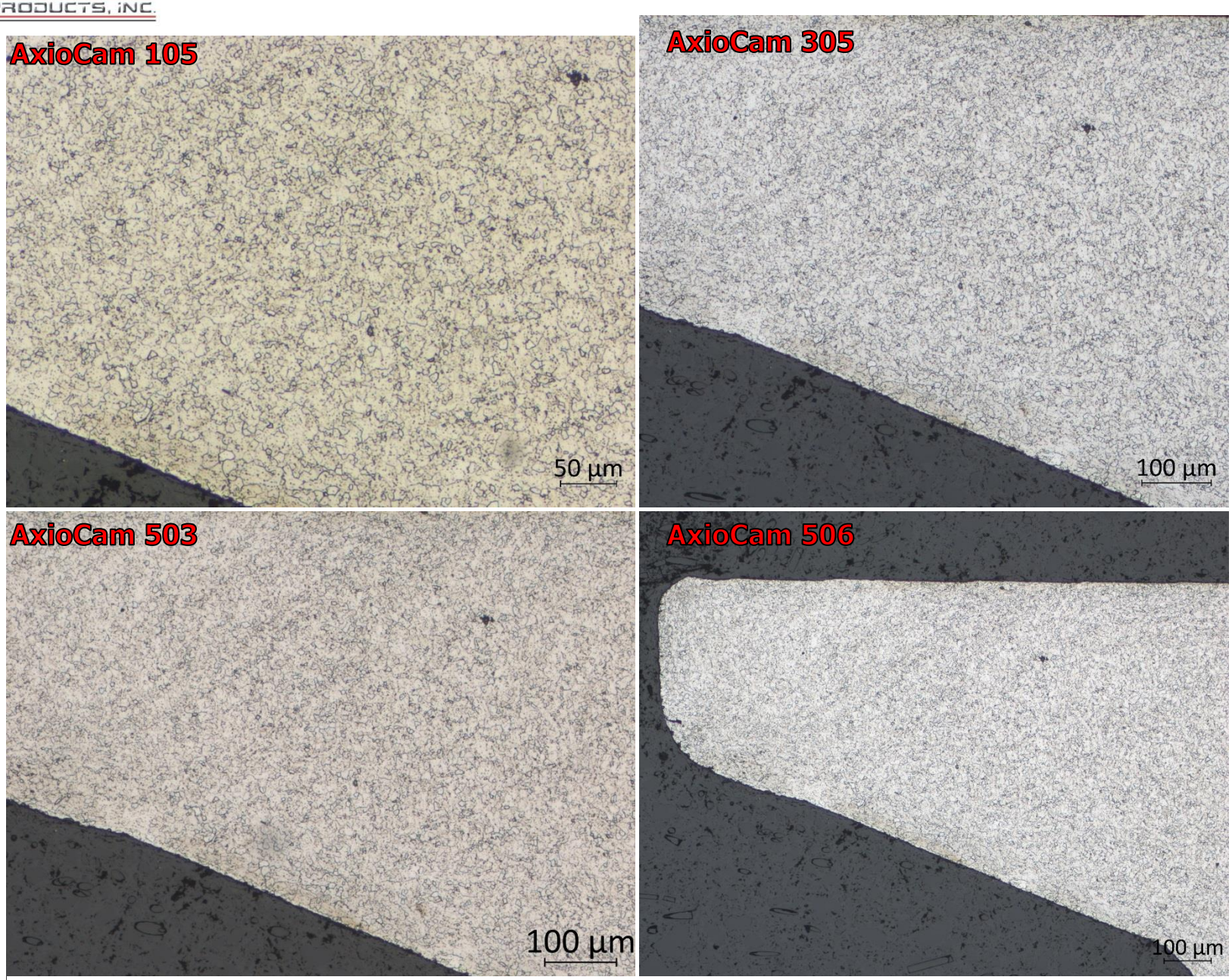

Figure 2: AxioCam comparison, 1X adapter, 10X objective, Brightfield

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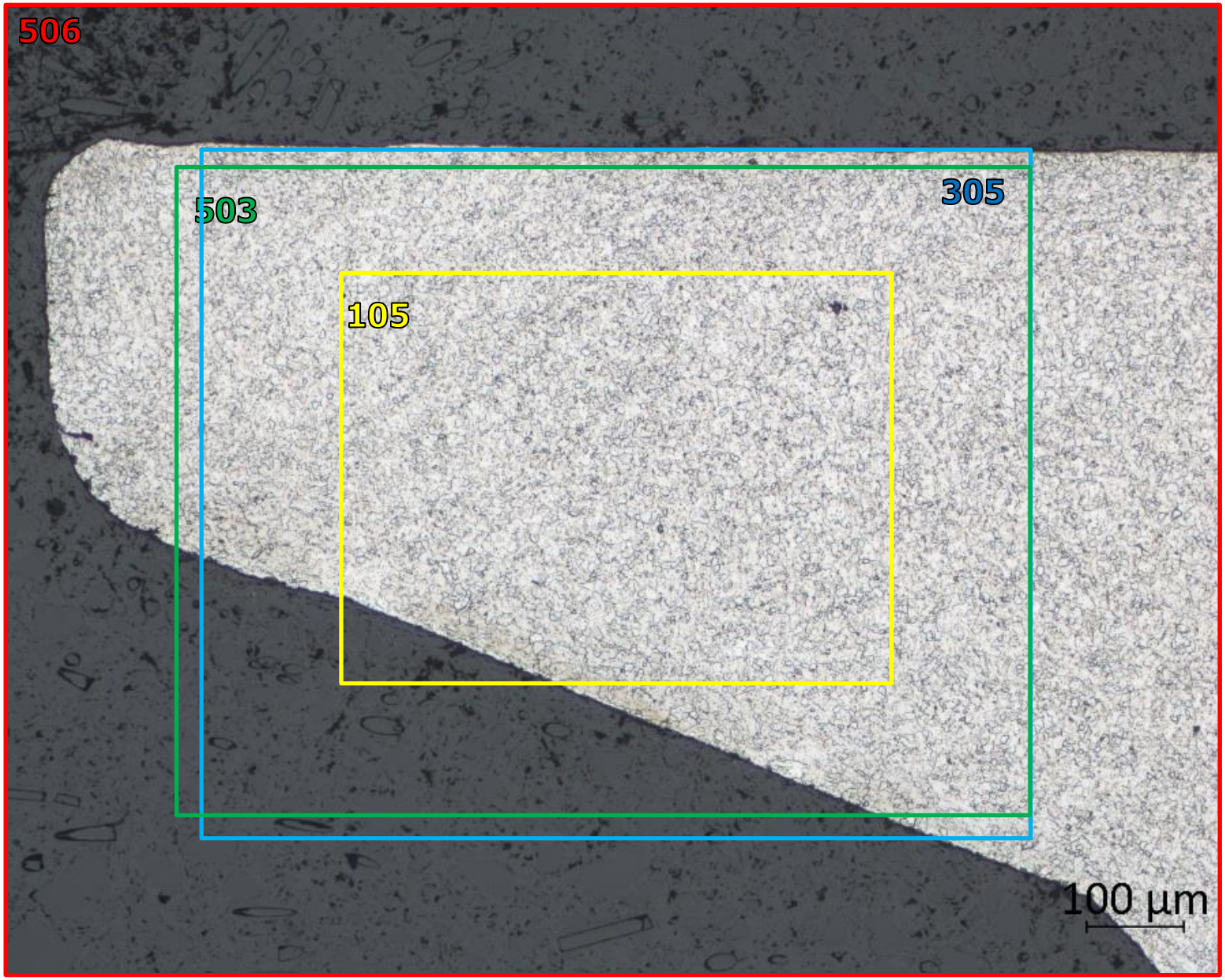

Figure 3: Camera field of view comparison

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Finding Magnified Dimensions

Finding the magnified dimensions of a sample can be easily calculated (Table 1). The information needed is:

- Camera Pixel Size: Can be found in the technical data sheet (Table 2)
- Camera Resolution: Can be found in the technical data sheet (Table 2)
- Camera Adapter: What is currently in use for the particular image
- Objective Used: What is currently in use for the particular image

Table 1: Equations for Finding Magnified Dimensions

Frame Size	(Pixel Size) * (Camera Resolution)
Largest Frame	Obtained from Frame Size (larger of 2 values)
Optics	(Camera Adapter) * (Objective)
Magnified Dimensions	(Largest Frame)/(Optics)

The following calculations are completed as examples:

1) AxioCam 506, 1X camera adapter, 10X objective
2) AxioCam 506, 0.5X camera adapter, 10X objective
3) AxioCam 506, 1X camera adapter, 5X objective

The following parameters are the same for all three examples:

- AxioCam 506 Pixel Size: 4.54 µm
- AxioCam 506 Resolution: 2751 x 2208

1) 1X Camera Adapter, 10X Objective

Frame Size = 4.54 µm * (2751 x 2208) = 12,489 µm x 10,024 µm
Largest Frame = 12,489 µm = 12.489 mm
Optics = 1X * 10X = 10X total magnification
Magnified dimensions = (12.489 mm)/10 = **1.2489 mm x 1.0024 mm**

2) 0.5X Camera Adapter, 10X Objective

Frame Size = 4.54 µm * (2751 x 2208) = 12,489 µm x 10,024 µm
Largest Frame = 12,489 µm = 12.489 mm
Optics = 0.5X * 10X = 5X total magnification
Magnified dimension = (12.489 mm)/5 = **2.4978 mm x 2.0048 mm**

3) 1X Camera Adapter, 5X Objective

Frame Size = 4.54 µm * (2751 x 2208) = 12,489 µm x 10,024 µm
Largest Frame = 12,489 µm = 12.489 mm
Optics = 1X * 5X = 5X total magnification
Magnified dimension = (12.489 mm)/5 = **2.4978 mm x 2.0048 mm**

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Table 2: Technical Specifications for Zeiss Axiocam Cameras

		Quantitative Analysis						Qualitative Analysis	
Camera		**506 Color**		**503 Color**		**305 Color**		**105 Color**	
Sensor		Sony ICX 694		Sony ICX 674		Sony ICX 264		Aptina	
Sensor Type		CCD II		CCD II		CMOS		CMOS	
Sensor Size		1"		2/3"		2/3"		2/5"	
Recommended Adapter		1x		1x		0.63x		0.5x	
Max FOV Adapter		1x		0.63x		0.63x		0.4x	
Dynamic Range		1:2500		1:2500		1:4800		1:200	
Exposure Time		250 µs to 60 s		250 µs to 60 s		100 µs to 4 s		100 µs to 2 s	
Digitization (Bit Depth)		3x14-bit		3x14-bit		3x12-bit 3x8-bit		3x8-bit	
Resolution		6 MP		2.8 MP		5 MP		5 MP	
Camera Resolution		6 MP		2.8 MP		5 MP		5 MP	
		2752 x 2208		1936 x 1460		2464 x 2056		2560 x 1920	
Pixel Size		4.54 µm		4.54 µm		3.45 µm		2.2 µm	
Binning Resolution	**1 x 1**	2752 x 2208		1936 x 1450		2464 x 2056		2560 x 1920	
	2 x 2	1376 x 1104		968 x 728		1232 x 1028		1280 x 960	
	3 x 3	912 x 736		640 x 484		816 x 684		N/A	
	4 x 4	688 x 552		480 x 364		608 x 514		640 x 480	
	5 x 5	554 x 440		384 x 292		480 x 410		N/A	
Live Image Frame Rate & Resolution	**Slow**	19 fps	2752 x 2208	38 fps	1936 x 1460	36 fps	2464 x 2056	15 fps	2560 x 1920
	Med.	33 fps	917x 733	76 fps	640 x 484	64 fps	1920 x 1080	37 fps	1280 x 960
	Fast	51 fps	550x 440	93 fps	384 x 292	88 fps	1232 x 1028	47 fps	640 x 480
Max. Image File Size, Color		36.4 MB @ 2752 x 2208, 3x14-bit		17 MB @ 1936 x 1460, 3x14-bit		30.24 MB @ 2464 x 2056, 3x12-bit		14.2 MB @ 2560 x 1920, 3x8-bit	
Max. Image File Size, B&W		12.2 MB @ 2752 x 2208, 14-bit		5.6 MB @ 1936 x 1460, 14-bit		10.08 MB @ 2464 x 2056, 12-bit		4.69 MB @ 2560 x 1920, 8-bit	
Peltier Cooling		Yes		Yes		Temp Stable @ 25° C		No	
Spectral Range		400 - 720 nm		400 - 720 nm		400 - 720 nm		400 - 650 nm	

Note: CCD vs. CMOS CCD (charge coupled device) and CMOS (complementary metal oxide semiconductor) image sensors are two different technologies for capturing images digitally. A CCD is an analog device. When light strikes the chip it is held as a small electrical charge in each photo sensor. The charges are converted to voltage one pixel at a time as they are read from the chip. Additional circuitry in the camera converts the voltage into digital information. A CMOS chip is a type of active pixel sensor. Extra circuitry next to each photo sensor converts the light energy to a voltage. Additional circuitry on the chip may be included to convert the voltage to digital data (From Wikipedia.org). **CCD tends to have a much higher dynamic range, uniformity, and lower system noise than CMOS, while CMOS tends to have a slightly better responsivity and speed than CCD. The CCD II has increased sensitivity and a more extended sensitivity range vs the CCD and CMOS to allow for lower image noise, exceptional dynamic range and minimal motion blur for sharp images at higher shutter speeds. Higher end CCDs outperform CMOS (see chart above).**

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AxioCam 105

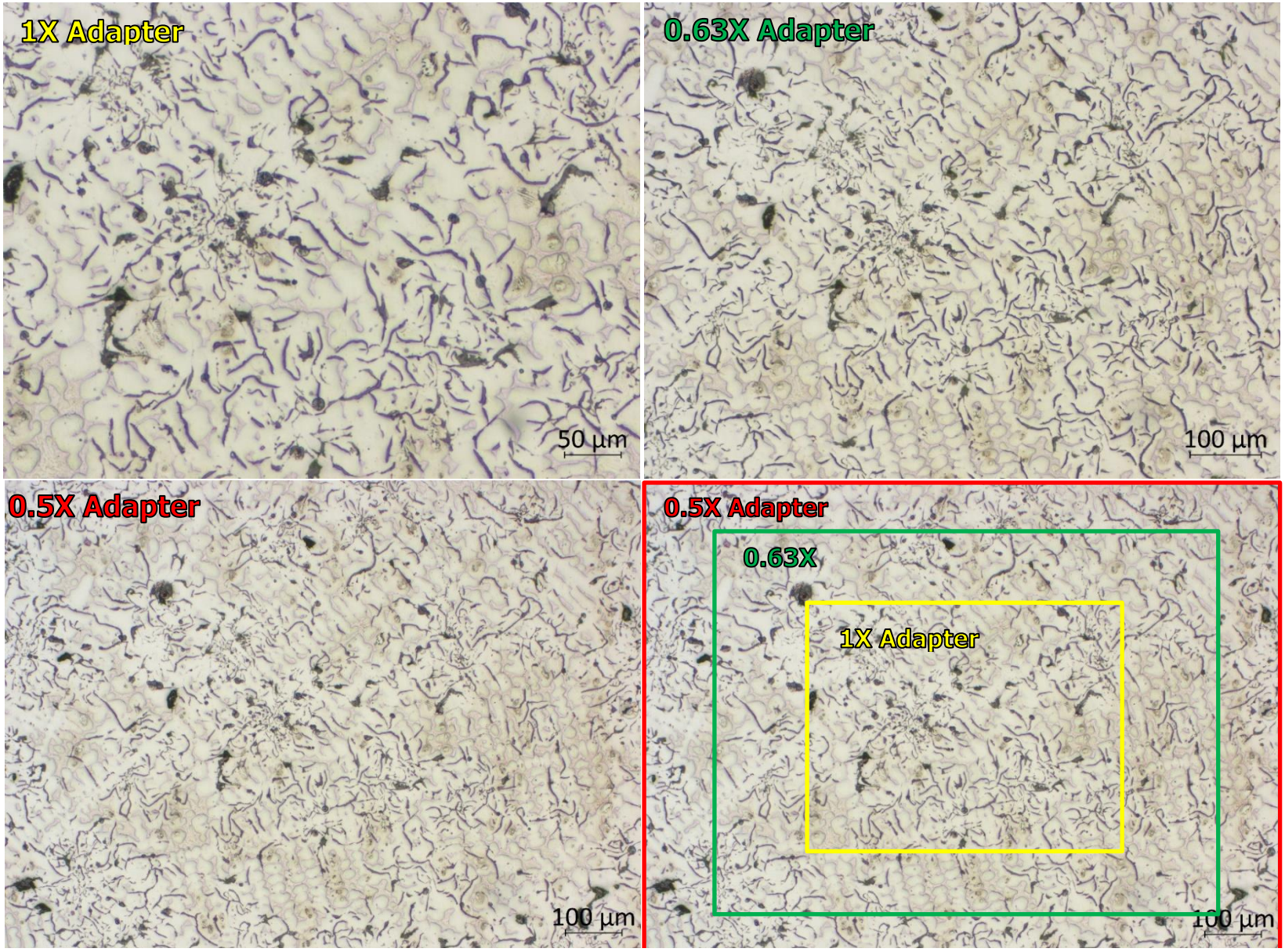

Figure 4: AxioCam 105 camera adapter comparison, 10X objective, Brightfield

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AxioCam 305

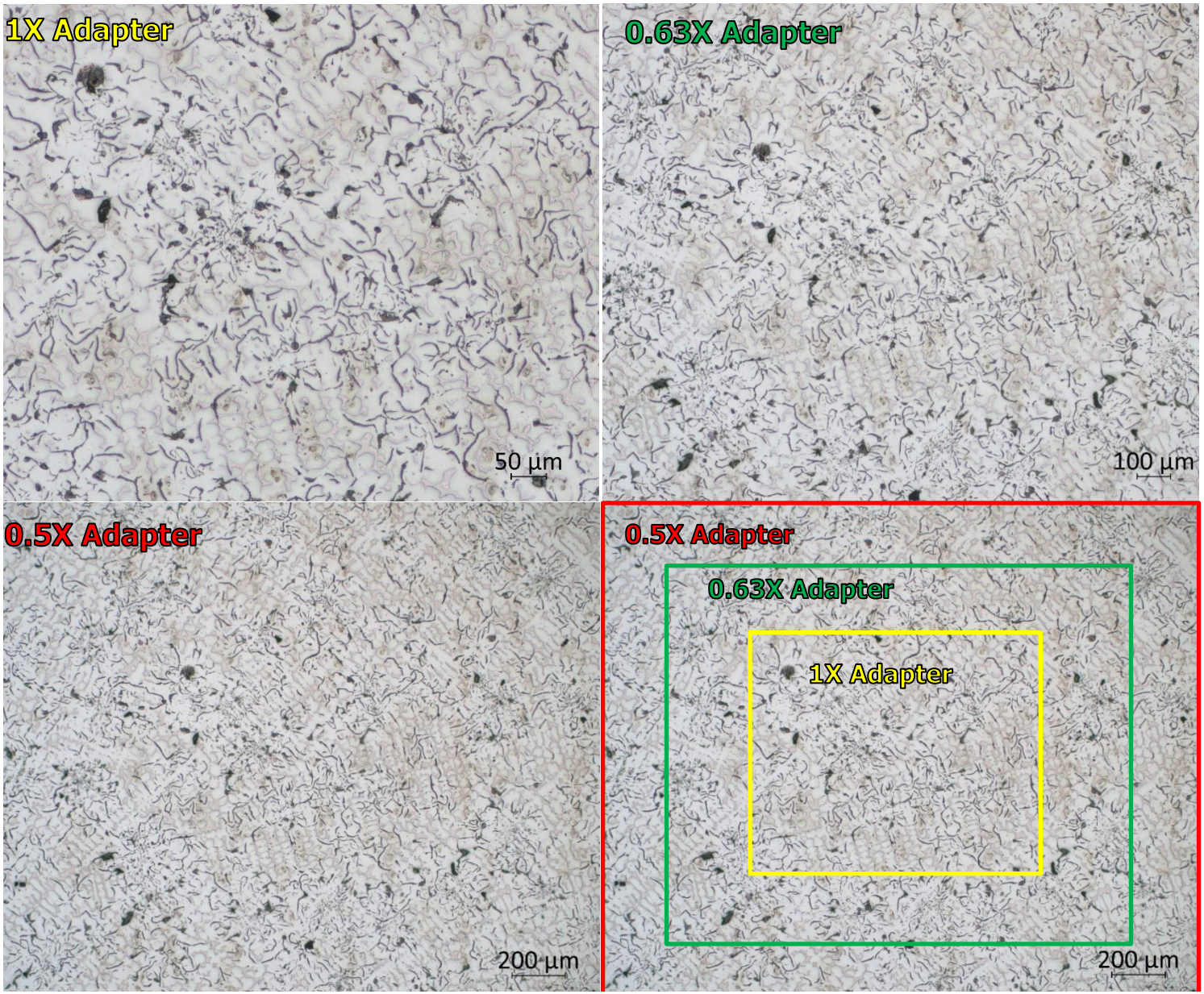

Figure 5: AxioCam 305 camera adapter comparison, 10X objective, Brightfield

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AxioCam 503

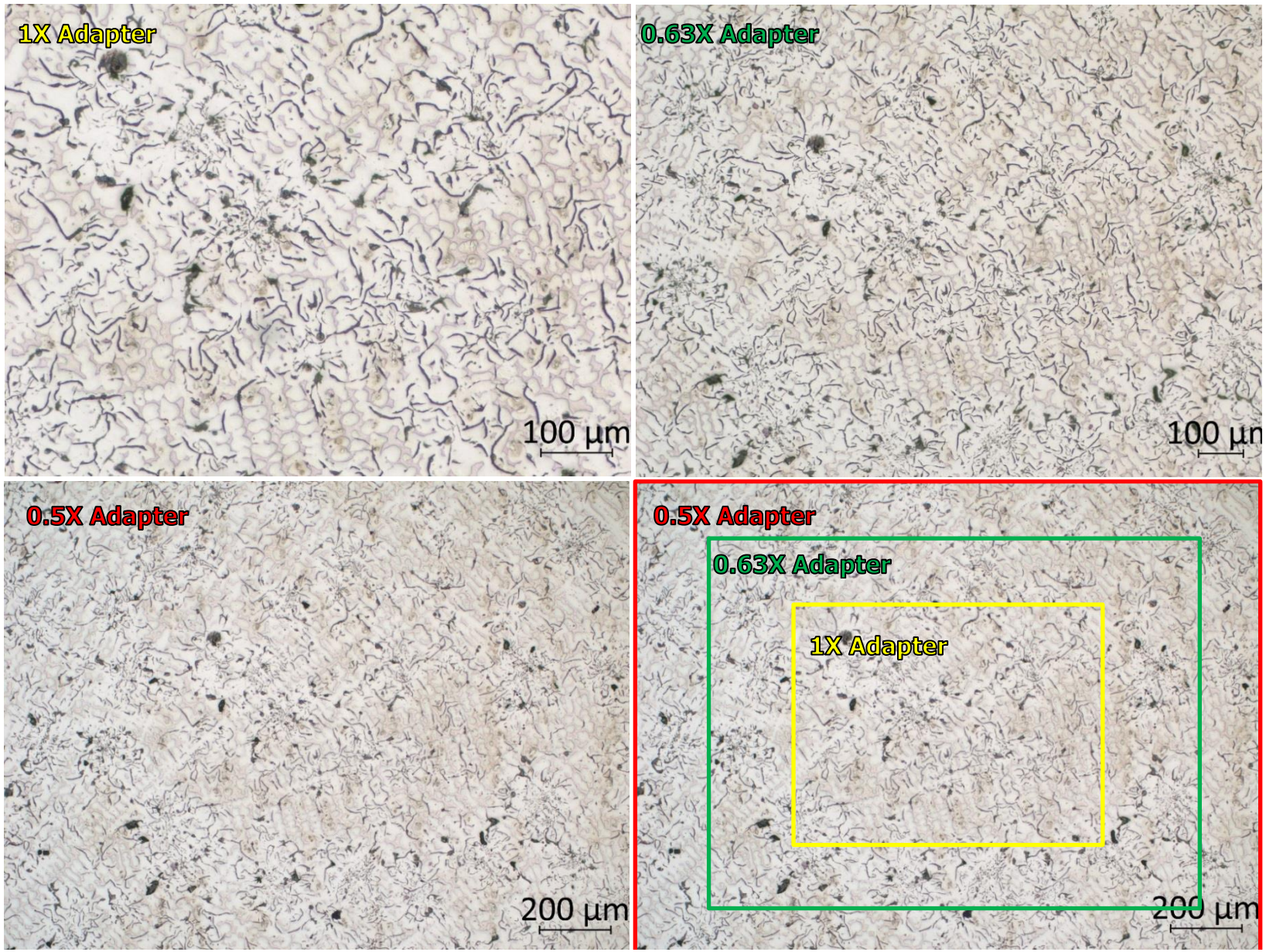

Figure 6: AxioCam 503 camera adapter comparison, 10X objective, Brightfield

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AxioCam 506

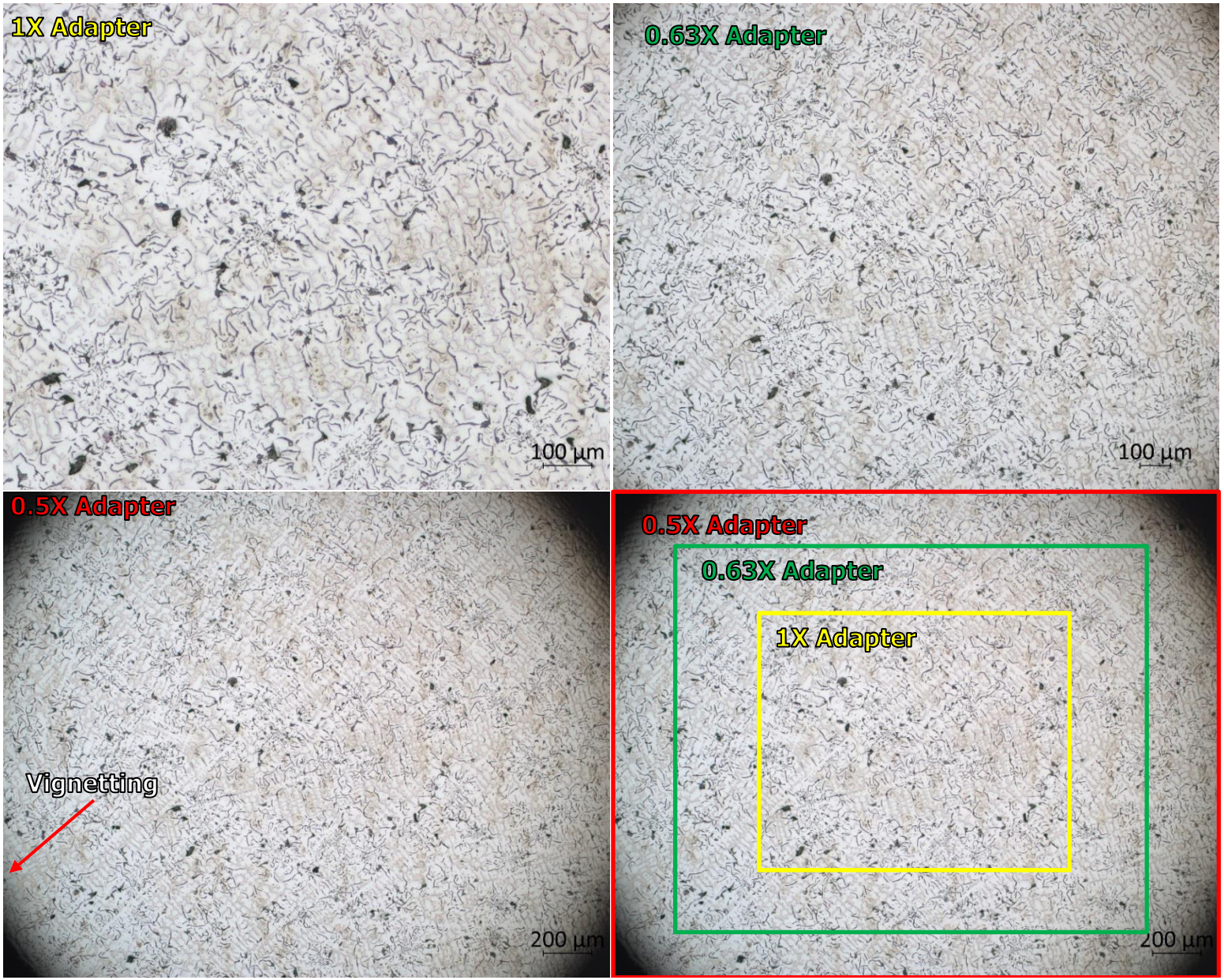

Figure 7: AxioCam 506 camera adapter comparison, 10X objective, Brightfield

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