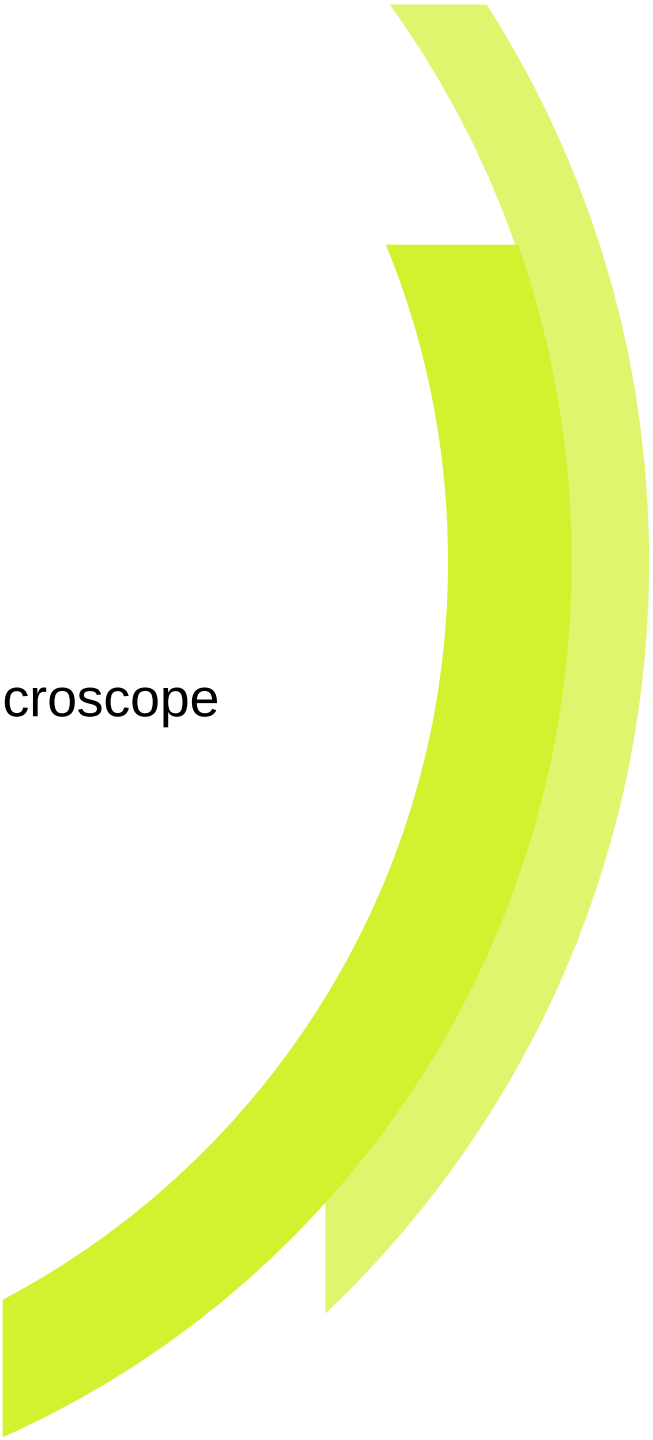

Infrared Upgrade for microscope

Prepared for	Riscure
Classification	Public
Type of document	Manual
Version	1.5
Date	27 May 2020

Riscure B.V.

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Table of Contents

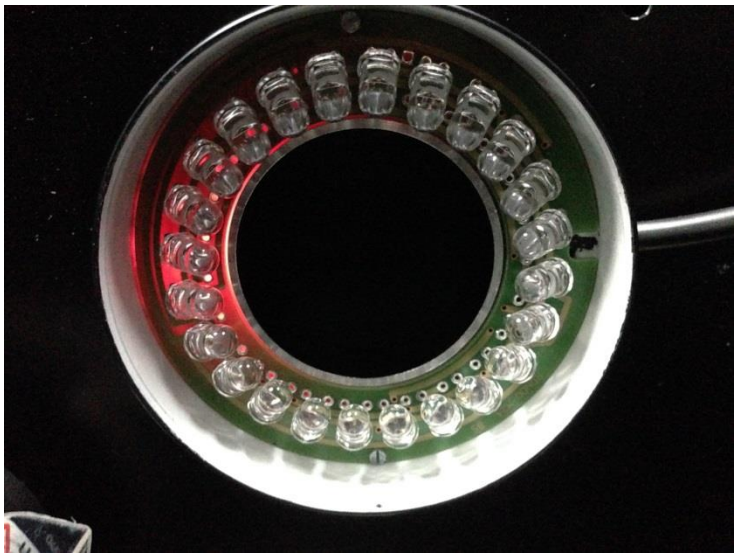
1 Safety

1.1 Optical safety

The Infrared Upgrade for microscope contains LEDs which make together a 2W light source. All LEDs are directed towards a single focus spot. The focus spot is on the center line of the ring light. The ring light has a working distance (WD) of 17 mm meaning that the focus spot is at 17 mm below the IR ring light. The wave length of the IR ring light is 1060 nm. This wavelength is not visible by the human eye.

The operator of the IR ring light should observe the general precautions:

- **DO NOT** stare into the IR ring light when switched on.
- **DO NOT** bring the IR ring light close to your eye (within 30 cm) when switched on.
- **BE WARNED** by red light coming from the inside of the IR ring light that that the IR ring light is switched on as you will not see the IR light coming from the ring of main LEDs.



The red LED on the back side of the printed circuit board warns you that the IR ring light is switched on.

1.2 Electrical safety

The IR ring light must be powered by a 12V power supply unit. The AC input to the 12V power supply unit is potentially lethal and is fully contained with the power supply unit.

- **DO NOT** open the 12 V power supply unit while the unit is plugged in. Opening the power supply unit may expose the operator to the unit's AC input power.
- **DO NOT** make or break any electrical connections to the system while the unit is switched on.

1.3 CE certification

EC-DECLARATION OF CONFORMITY

Suppliers Details

Name

Riscure B.V.

Address

Frontier Building, Delftechpark 49, 2628 XJ Delft, The Netherlands

Product Details

Product Name

Inspector

Model Name(s)

IR ring light

Trade Name

Riscure

Applicable Standards Details

Directives:

- LVD (2006/95/EC) - EMC directive (2004/108/EC)

Standards:

- IEC 60825-1; IEC 320 C8; IEC 60950-1; 21 CFR 1040; ANSI/ESD S20.20:2007; BS EN 61340-5-1:2007; EN55022-B; EN61000-4-2, 4-5; CISPR 11; CISPR22-B; UL 1950

Supplementary Information

The appliance fulfils the relevant requirements of the EMC-directive and the LVD-directive according to our technical documentation TCD-IR ring light.

Declaration

I hereby declare under our sole responsibility that the product(s) mentioned above to which this declaration relates complies with the above mentioned standards and Directives

Riscure B.V.
Frontier Building
Delftechpark 49
2628 XJ Delft
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Tel.nr.: +31 (0) 15 251 4090

Name	Issued Date
Dr.ir. F.G. de Beer / Technical Director	26 / 06 / 2014

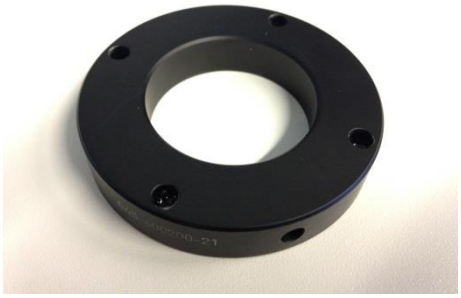
Signature of representative

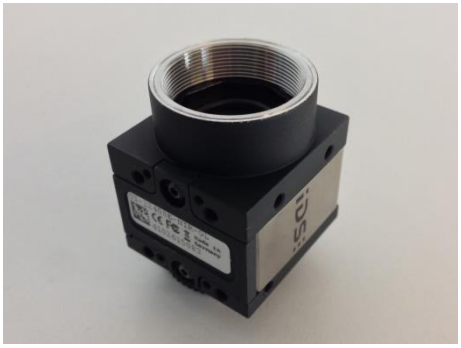
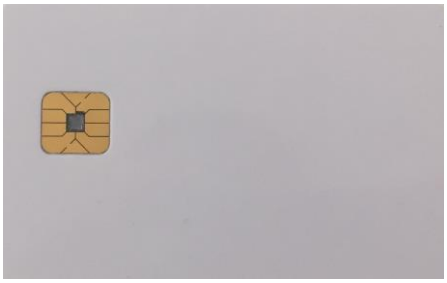
2 Infrared upgrade for microscope

This package contains the IR ring lights, power supply, camera and accessories. Please go through the list to verify your package is complete. For setup instructions, see the setup instructions section.

Package contents

Below is a list of the standard contents of this package. Please check whether you have received everything you should have. For your convenience a short description of all items is included. If you are missing anything, please contact us at https://support.riscure.com.

	**IR ring light 17 mm WD** The IR ring light has 24 LEDs which are directed to a focus spot on the centre line at 17 mm below the ring light. The wave length is 1060 nm. The ring light needs a power supply of 12 V and consumes approximately 2 W. At the other side, the ring light is equipped with screw thread to connect a ring with magnets. .
	**Magnet rings with hexagonal socket screws (3x)** The hexagonal socket screws should be tightened with a 1.5 mm hexagonal key to fix the magnet ring on to the objective. The magnets align with the magnets in the magnet ring with screw thread

	**NIR camera** The IDS UI-1240SE-NIR-GL camera has good sensitivity for the 1060 nm wave length of the IR ring lights.
	**USB cable for NIR camera**
	**Smart card with backside decapped**
	**12V DC 3.5A power supply**

3 Setup instructions

The basic setup instructions are as follows:

3.1 Mounting the camera

Mounting of IDS UI-1240E-NIR-GL camera on camera tube of microscope

The camera is shipped with a dust protection cover. This cover needs to be removed. An aluminum c-mount adapter interfaces between the camera and the camera tube. The camera should be mounted to the adapter using the thread. The adapter is fixed in the camera tube by three hexagonal screws. After untightening these screws, the camera can be rotated to align the top of the camera image to the top of the die. After alignment, the screws should be tightened. The USB cable connects the camera to the PC. When the proper driver is installed, the LED on the camera will switch from red to green after several seconds.

3.2 Assembly of 17 mm WD ring lights to objective

Mounting of magnet ring on 5x objective by tightening socket screws

Fix the magnet ring with hexagonal socket screws to the objective by tightening the screws as indicated in te picture.

Attaching 17 mm WD IR ring light to magnet ring on 5x objective

Screw the magnet ring with screw thread to the 17 mm WD ring light and connect both to the objective by aligning the magnets.

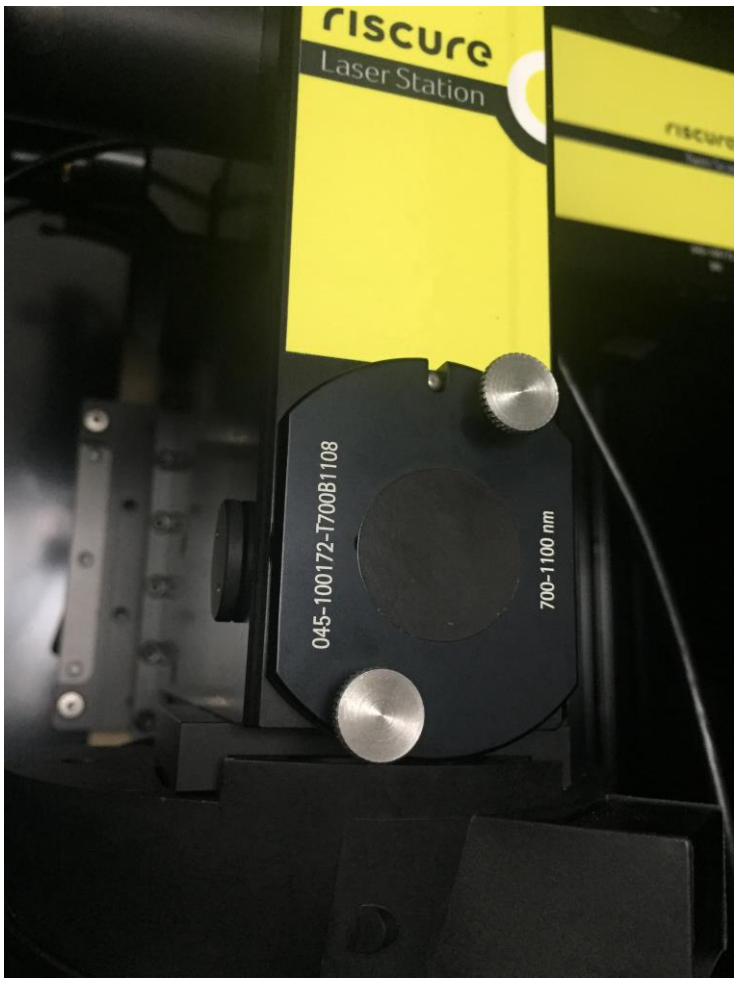
Connect the 12 V power supply to the ring light and to mains.

3.3 Removing of beam splitter (LS2)

With the LS2 to have an optimal light path from the IR camera to the target surface,

Remove the beam splitter from the body of the LS-2 by unscrewing the two screws underneath the Riscure Laser Station logo.

- Warning: Place the beam splitter back in the LS2 when using the laser again. This will prevent emission of laser beam radiation to escape the beam splitter aperture.



LS-2 body with Beam splitter mounted

Beam splitter

3.4 Installation of camera software

This section describes the steps necessary to install and configure the uEye camera for use with Inspector or for use with the IDS tools like uEye Cockpit

Make sure all installers are copied to a local drive, because during installation the network will disconnect.

3.4.1 DirectX

Install DirectX 9.0c end-user runtime from June 2010.

1. Start directx_Jun2010_redist\dxsetup.exe
2. Accept license agreement and click Next
3. Click Next
4. Click Finish

3.4.2 Driver

Download the IDS Software Suite 4.41 64-bit from http://en.ids-imaging.com/download-ueye.html (registration is required). The download contains the uEye64_44100.exe installer.

Install the uEye driver bundle for 64-bit systems. Instructions between brackets are only relevant if a previous version of the uEye driver was installed.

1. Start uEye64_44100.exe
2. (Choose remove and click Next)
3. (Click Yes)
4. (Click Yes)
5. (Click OK)
6. (Select “Yes, I want to restart my computer now” and click Finish)
7. (Start uEye64_44100.exe again)
8. Select “English (United States)” and click Next
9. Click Check USB bus
10. Check for green text stating “USB 2.0 compatible Host controller found”
11. Click Exit
12. Choose “Install driver”
13. Choose “1. Complete” and click Next
14. Click Next
15. Click Next
16. Click Install
17. Click OK
18. Uncheck “Show quickstart HTML” and click Next
19. (If a warning about Intel Core i7 appears click OK)
20. Click Finish
21. Reboot computer

3.4.3 DirectShow

Download the DirectShow driver for uEye cameras 4.41 (32 and 64 bit) from the http://en.ids-imaging.com/download-ueye-interfaces.html website. The download contains the uEye_DirectShow_44100.exe installer.

Install the DirectShow interface for uEye. Instructions between brackets are only relevant if a previous version of the uEye DirectShow interface was installed.

1. Start uEye_DirectShow_44100.exe
2. (Select “Remove uEye DirectShow completely” and click “Next”)
3. (Click Yes (twice if necessary))
4. (Select “Yes, I want to restart my computer now” and click Finish)
5. (Start uEye_DirectShow_44100.exe again)
6. Select “English (United States)” and click Next
7. Click Next
8. Check “Register cameras on connect” and “Use camera names” and click Next
9. Close WhatsNew
10. Click Finish
11. Reboot computer

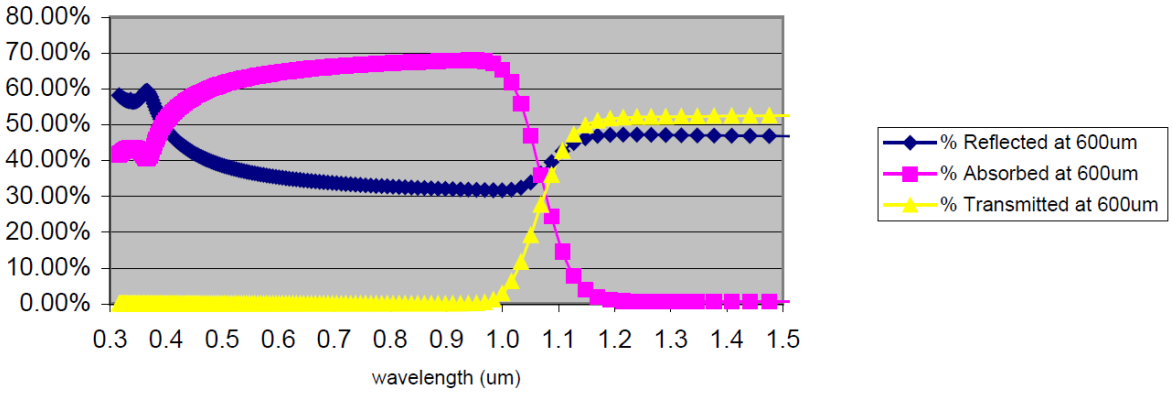
3.4.4 Configure

Configure the IDS camera software.

1. Start IDS Camera Manager
2. When asked about network service click Cancel
3. Click “Additional functions”
4. Under “CPU idle states” check “Disable (mains power)”
5. Click Close

4 Design considerations

4.1 Wavelength of IR LEDS



Optical characteristics of silicon versus wavelength

The choice for the 1060 nm LED is a trade-off between two effects;

- The silicon substrate is transparent for 1060 nm and longer wavelengths [1], see figure above.
- CCD cameras are sensitive for 1060 nm and shorter wavelengths.

4.2 Comparison of camera's

We compared three camera types:

- Color camera for visible light (IDS 100-DC-C1130511) which is the standard option for the diode laser station. This camera is equipped with an IR filter and is not suitable for 1060 nm wavelength.
- Monochrome camera for near infrared light (IDS UI-1240E-NIR-GL) which is intended for use with the IR ring light. The IDS UI-1240E-NIR-GL camera has increased sensitivity for NIR light compared to IDS 100-DC-C1130511.
- Monochrome camera for near infrared light with cooled CCD sensor (SXVR-H9) which is selected for comparison. The cooling of the sensor reduces back ground noise.

The following images were taking under similar conditions.

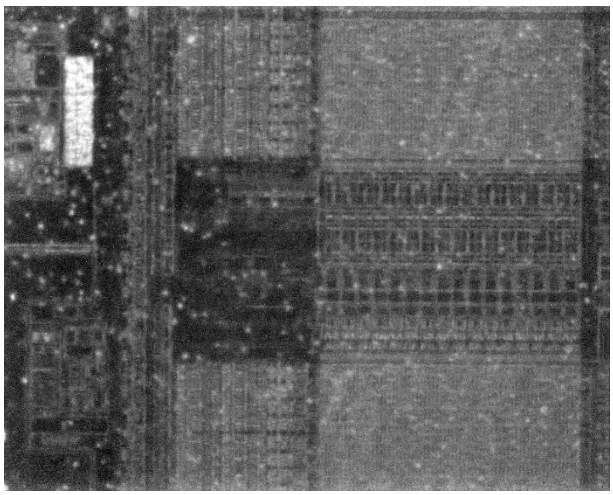


Image captured with monochrome NIR camera which is intended for use with the IR ring light

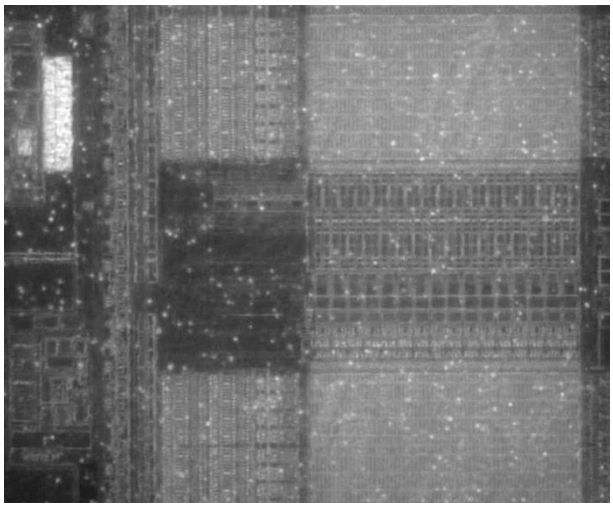


Image captured with cooled monochrome NIR camera

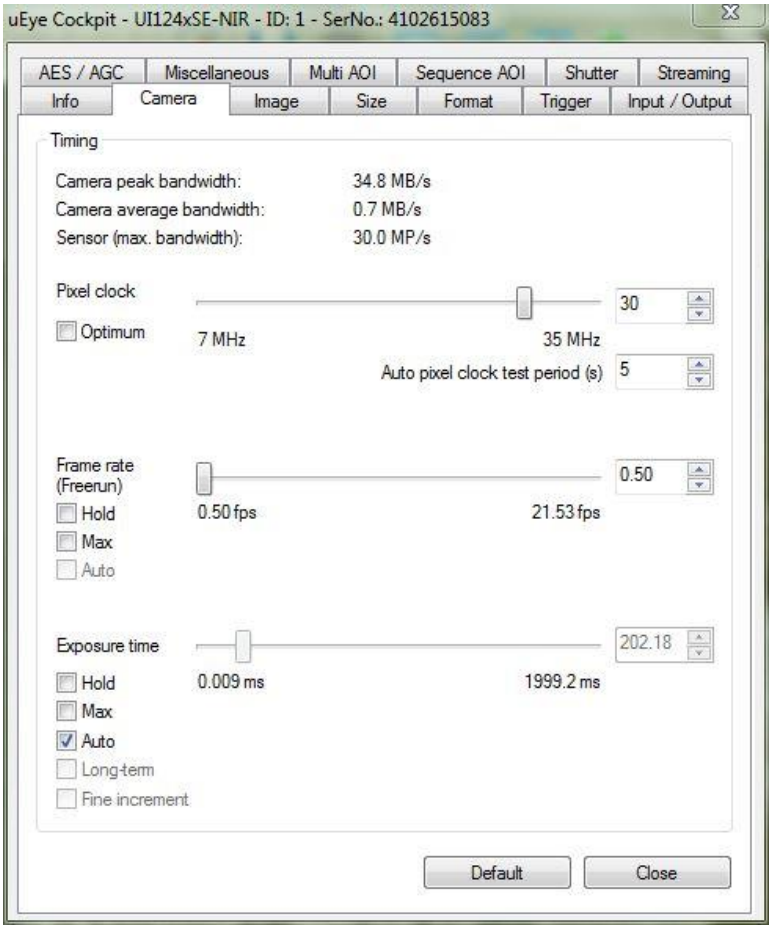
Comparison of the two images shows that the images of the NIR and cooled NIR camera have approximately similar image quality. The sensor cooling does not seem to be necessary, given the light intensity of the IR ring light. We selected the IDS UI-1240E-NIR-GL for use with the IR ring light for backside navigation.

5 Operating tips

The images in this chapter are taken from a smart card chip used in Riscure's training card 2, 3, 6, or 4. The chip's package is opened. For some images, the back side is polished but not significantly thinned. We estimate the thickness of the silicon substrate to be more than 200 µm. The image area for the 5x objective is approximately 1 x 1 mm.

5.1 Taking images and camera exposure time

Images can be taken via the uEye Cockpit camera software by IDS. After starting uEye Cockpit, select the monochrome option. The exposure time for the camera should be between 0.5 and 2 s. The settings can be entered via uEye > properties, see screenshot below.



Screenshot of camera properties in uEye Cockpit

5.2 Improving image quality with immersion oil

5.2.1 Improving with immersion oil

The image quality strongly depends on the quality of the back side surface. A surface with scratches and dents blurs the image. A way to improve the image quality is to fill the dents and scratches with a fluid with the same refractive index as the silicon substrate. However, the refractive index of silicon is approximately 4 and fluids have a refractive index up to approximately 1.5.

The images below are taken with and without silicone oil. Silicone oil has a refractive index of approximately 1.5. The effect of covering the surface with silicon oil is considered to be minimal.

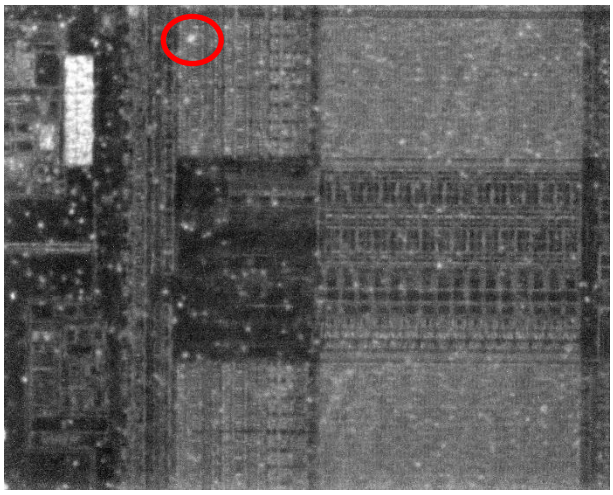


Image captured with monochrome NIR camera

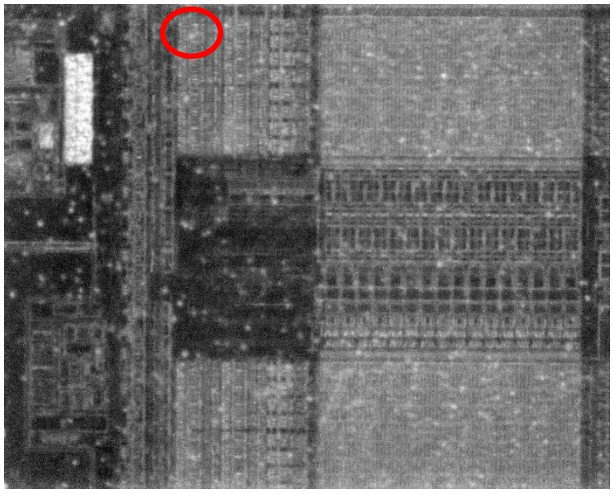


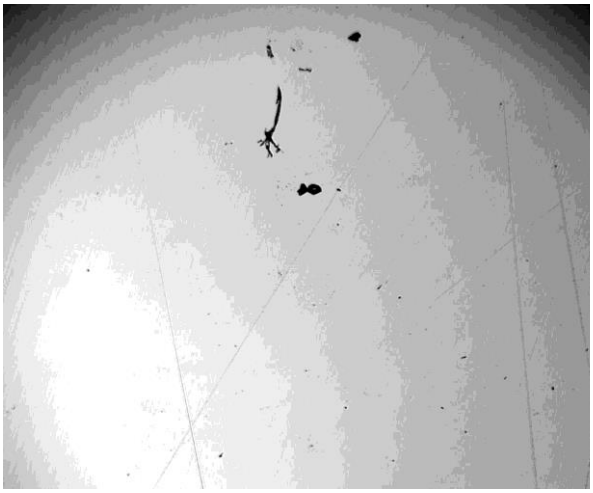
Image captured with monochrome NIR camera and surface covered with silicon oil

5.2.2 Improving image quality by surface polishing

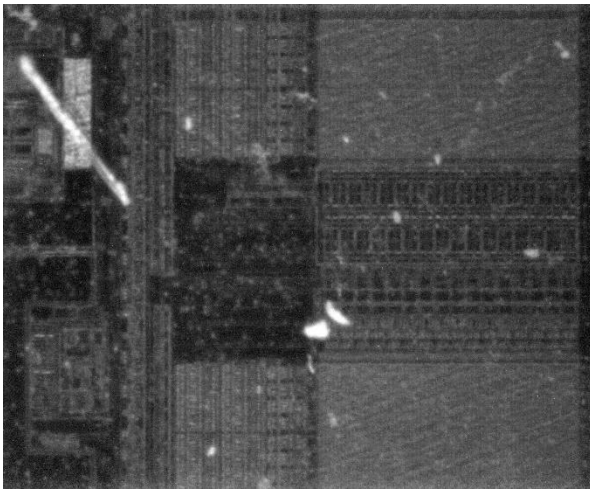
As the image quality strongly depends on the quality of the back side surface and polishing helps to reduce dents and scratches, polishing will improve image quality. The images below show the surface and transistor layer for unpolished and polished samples. The polishing was done in two phases:

- with a dry 1 µm polishing disc. Unfortunately this caused additional long and deep scratches
- with glycol based 0,05 µm polycrystatalline diamond suspension.

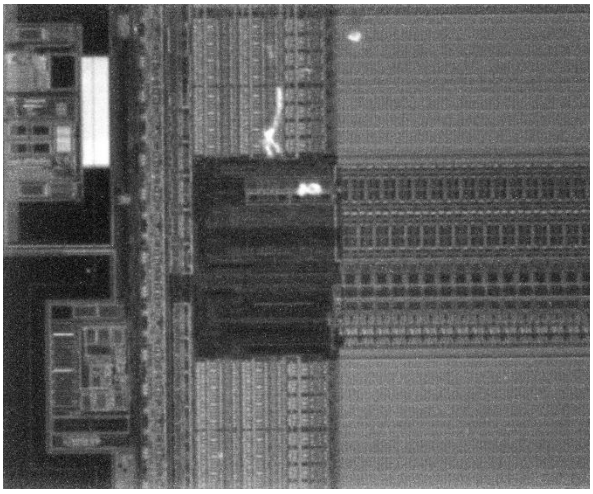
Surface image of unpolished sample at location A



Surface image of polished sample at location A

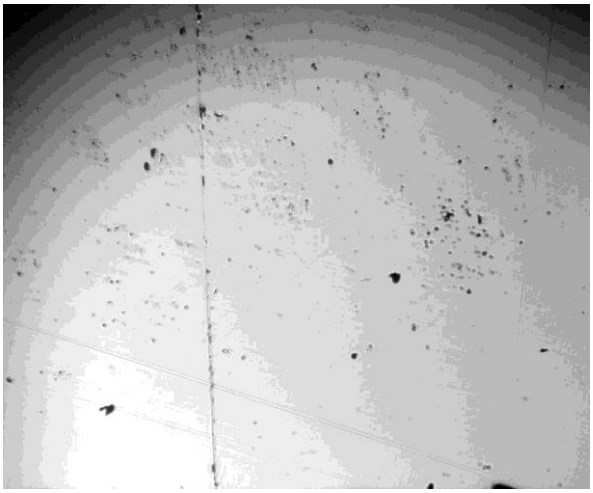


Transistor layer of unpolished sample at location A

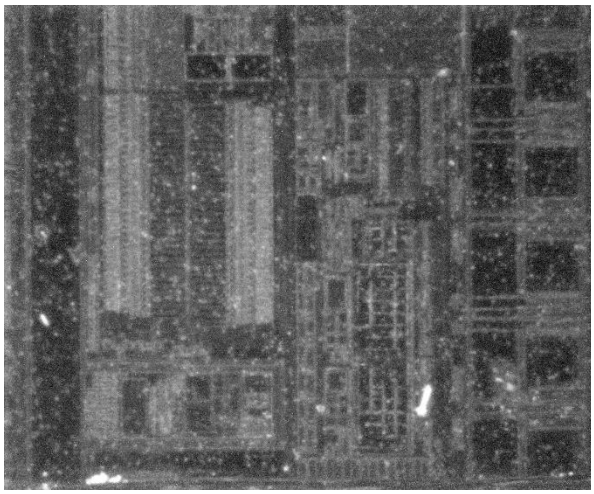


Transistor layer of polished sample at location A

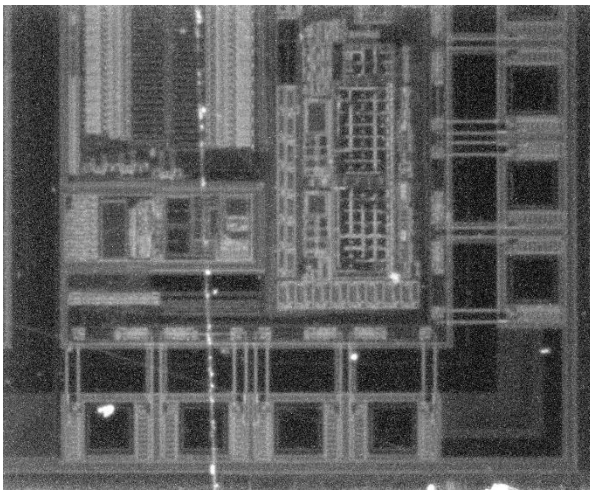
Surface image of unpolished sample at location B



Surface image of polished sample at location B



Transistor layer of unpolished sample at location B



Transistor layer of polished sample at location B

The effect of surfaced polishing is significant.

5.3 Focusing

5.3.1 Focusing the 5x objective

The focus distances between the object and the microscope's objective are approximately the same for:

- focusing on the back side surface with visible light and
- focusing on the transistor layer through the back side with 1060 nm IR light

This is illustrated by the following two images which are taken without intermediate adjustment of the focus distance.

Hence, an easy procedure to find the focus distance for the transistor level is to first find the focus distance for the back side surface using visible light. The explanation of this phenomenon is two-fold:

- The refractive index of the silicon substrate is approximately 4 compared to a refractive index of air of approximately 1. The change of direction of light at the surface between silicon and air due to the large difference in refraction indices shifts the focus level in the direction of the surface.

.

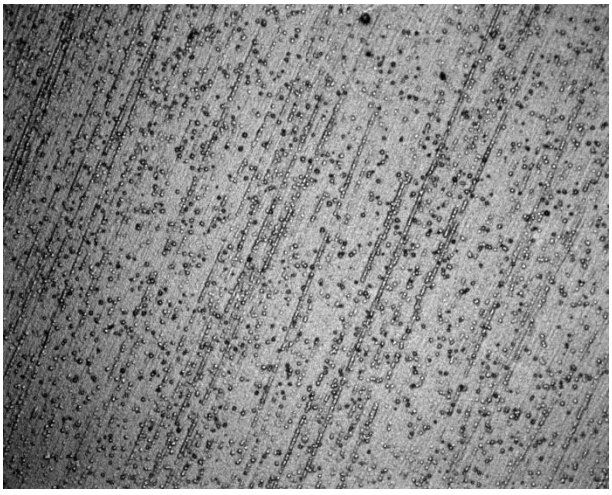


Image of back side surface with visible white light. Dents and scratches of the unpolished backside are visible

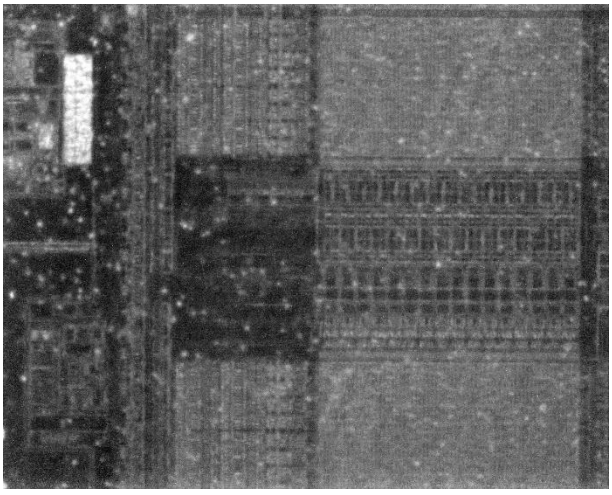


Image of transistor layer with 1060 nm IR light and 5x objective. The unpolished surface blurs the image to some extent.

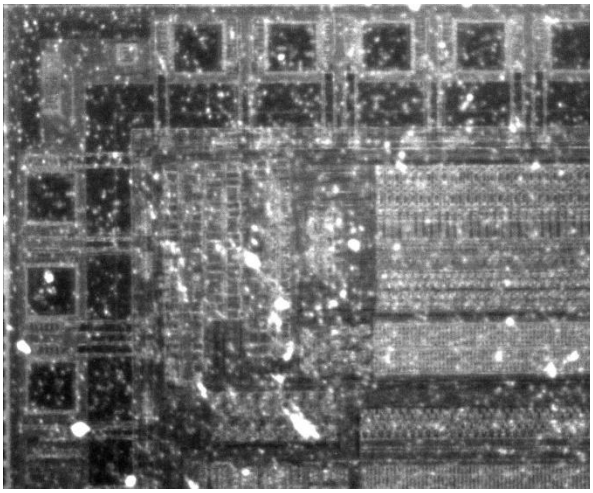
5.3.2 Focusing the 20x and 50x objective

The focus depth of the 20x and 50x objective is significantly smaller compared to the 5x objective. Focusing of the backside surface and transistor layer cannot be performed simultaneously. Starting with the backside surface focused, the user needs to slide down the 20x or 50x objectives to get the transistor layer into focus.

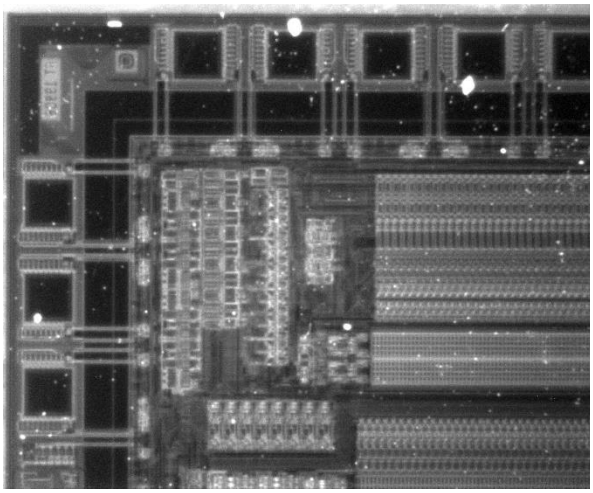
5.3.3 Making use of limited focus depth of 20x and 50x objectives.

The limited focus depth of the 20x and 50x objectives is useful to blur the irregularities of the backside image while observing the details of the transistor layer. The 5x, 20x and 50x images below of an unpolished sample illustrate this. As a reference the images of an polished sample are also given.

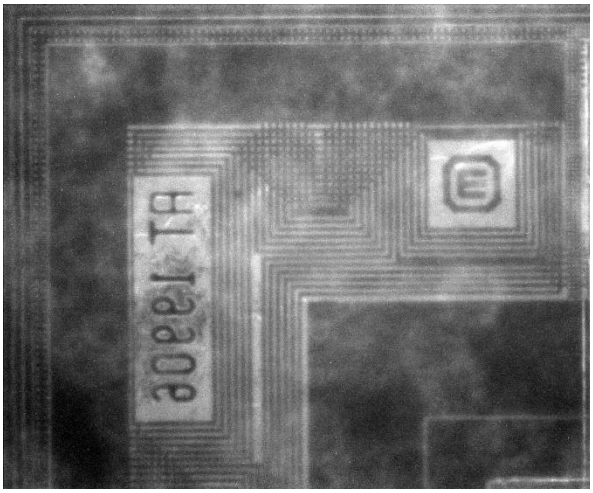
The image quality difference between unpolished and polished is very clear for the 5x objects and much less clear for the 50x objective.



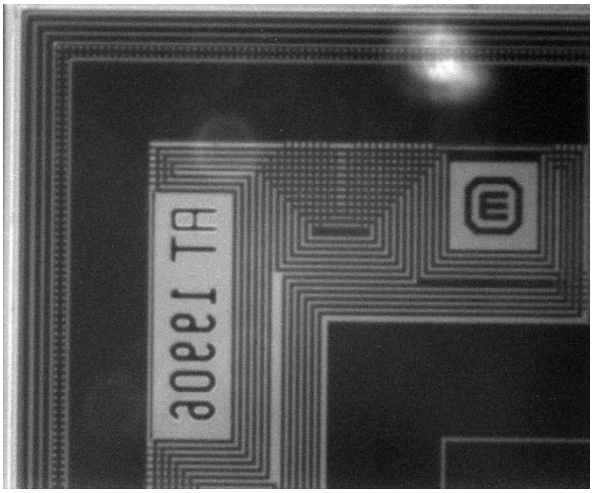
unpolished sample with 5x objective



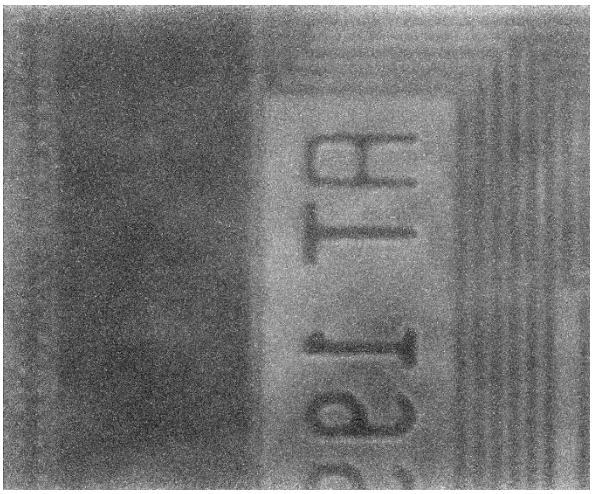
polished sample with 5x objective



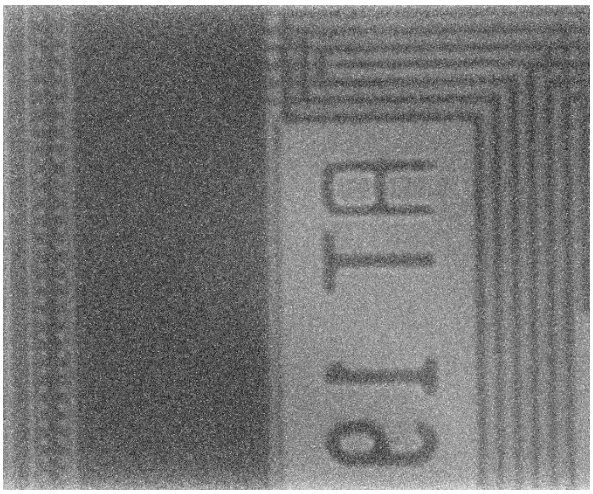
unpolished sample with 20x objective



polished sample with 20x objective



unpolished sample with 50x objective



polished sample with 50x objective

5.4 Image example of TC4 (provided as part of package)

This example on the TC4 is done without need of polishing the surface.

The pictures are taken under a LS2 without a beam splitter.

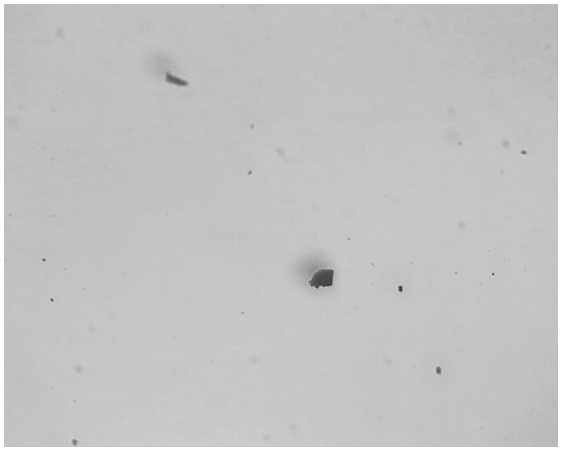
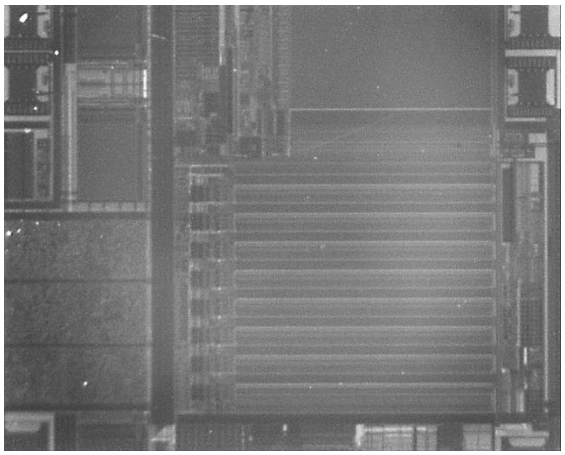


Image of back side surface with visible white light.



unpolished TC4 with 5x objective

6 Support (https://*support.riscure.com*)

Installation questions can be posted through our support portal at https://support.riscure.com. Additionally, you may contact our office by telephone at +31 152 514 090.

7 References

[1] Optical properties of silicon, Virginia Semiconductor, Inc.