MorphCol Supplement #22 - Lagrangian Illumination for AMOR

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Introduction

Sufficient illumination of specimens is critical for AMOR to automatically localize and move specimens in the desired orientation. During development of AMOR, the standard illumination was hitherto a combination of a fiber-optics ring-light from above and two opposite and sidewardly oriented arms of a swan-neck fiber optics illumination. Using crossed polarizing filters disturbing reflections and shadow generation could be reduced. However, during operation the geometry of the illumination proved not ideal, leading to unfavorable incident angles of the light when the stage attained strong tilting. Such situations caused unfavorable light loss due to the local geometry of the slide holder or poor illumination on the opposite side of the specimens leading to malfunction of the automatic orientation.

In order to avoid such difficulties, a bright LED illumination was designed in collaboration with students from the Institute of Automation at the Applied University of Northwestern Switzerland (FHNW, unpublished student project of Schneider and Chalençon, 2012). This device has two perpendicular sets of parallel rows of power-LEDs mounted directly on the moving slide holder and at close distances to the specimens (Figures 1-5). With this geometry the light source moves and tilts in the same coordinate system as the stage, for which the term "*Lagrangian illumination*" is coined here. The term Lagrangian is often applied in fluid dynamics for study approaches, where the observer (in our case the light) moves together with the local particle (the microfossil) under consideration, in contrast to Eulerian movements, where the observer (light source) remains fixed, while the observed particle (microfossil) passes by. This Lagrangian setting has the consequence, that the illumination of the particle remains constant and bright, regardless of the movement of the stage. The cost is, that polarizing filters are physically difficult to install in front of LEDs.

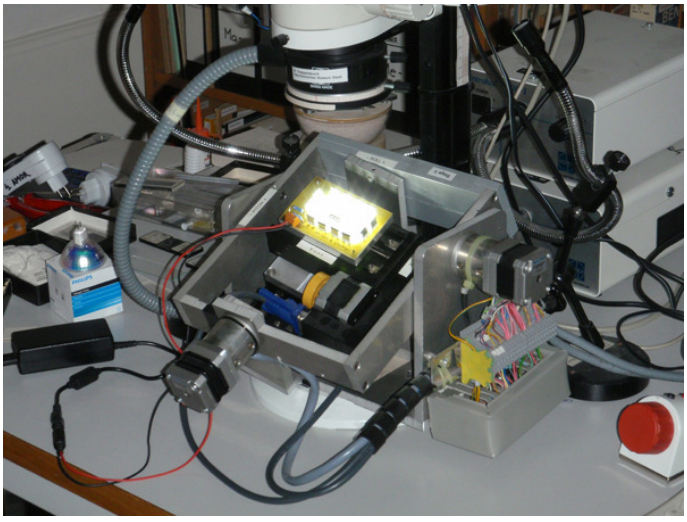

Figure 1
Lagrangian illumination for AMOR

The illuminating power LEDs move together with the specimens and so allow for constant illumination angles with respect to the specimen under consideration.

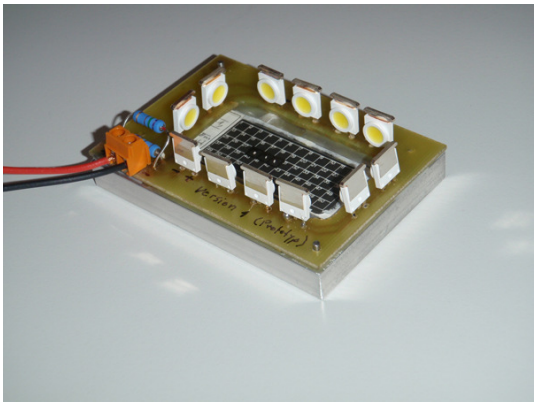

Figure 2
Power LEDs are mounted on an electronic circuit plate around the slide in proximity to the specimens.

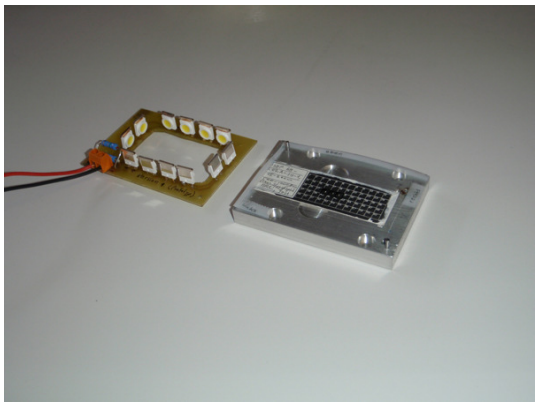

Figure 3
Metal base plate holding the multi-cellular slide (right) and electronic circuit plate holding the LEDs (left) separated. When in operation, the two units must be insulated from each other.

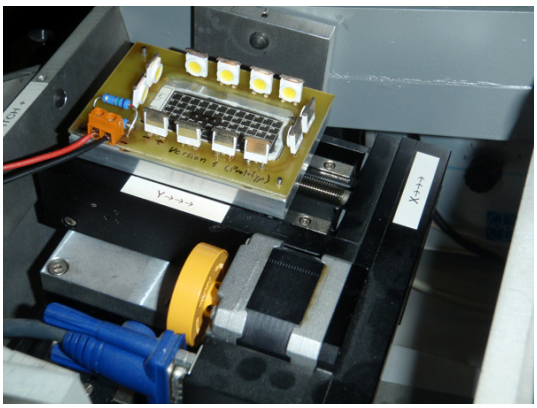

Figure 4
The illumination mounted on the tilting stage.

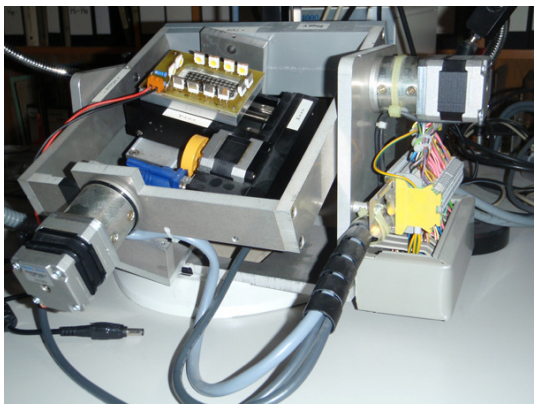

Figure 5
Illumination angles relative to the specimens remain independent from the tilting position of the stage.

Choice of the light source

Originally, it was planned to illuminate the specimen using an commercially available array of bright light emitting diodes (LEDs), that can be fixed underneath the objective lense to illuminate the specimens from above. Soon, however, it was realized, that this setting produces undesired changing light intensity as the microscope moves up and down while focusing (see measurements with the fiber-optics ring light in MorphCol supplemet #21).

The solution out of this dilemma was the device illustrated on Figure 2 consisting of 3 parts, i.e.

1.) An aluminum base sample holder which can be fixed on the motor stage,
2.) a frame-like electronic circuit plate that holds and feeds the LEDs, and
3.) a thin insulator foil in between in order to prevent electric short-circuit between base plate and circuit plate (see Figure 3).

The microfossils are mounted on a standard multicellular slide, with the cardboard frame removed. The checkered cardboard with the microfossils fits precisely in a cavity of the base plate, so that no shadows from side-walls are generated from sideward illumination.
After placing the insulation frame (a plastic foil) on the base plate, the circuit plate can be mounted (Figure 2). LEDs produce sideward light, each at overlapping viewing angles of 110°. LEDs are Moonstone 1W Power LEDs from AVAGO Technologies. They produce cool white light of 80 lm, which was found to be sufficient for distances between LED and microfossils of about 20mm (i.e. the inner width of the microfossil slide) and for maximum microscope magnifications used in AMOR.

Electronic circuit and power supply
The electronic circuit was specially designed at FHNW for this purpose. It was designed to feed the LEDs via a 17V/350 mA direct current power supply with sufficient electricity without becoming too hot for permanent operation.

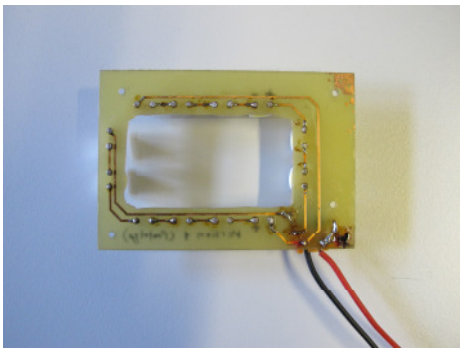

Figure 6
Electronic circuit plate seen from below showing wiring.

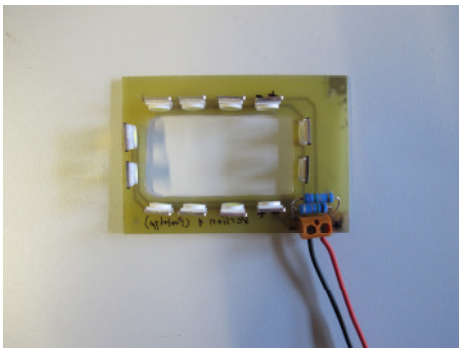

Figure 7
Electronic circuit plate seen from above (mirrored) showing corresponding LEDs, resistance, and lead to power supply.

Experience with AMOR
Experimentation using the new illumination in combination with AMOR 3.17 revealed good results. Although no polarized light can be used any longer when the new device is used, reflections from the background of the slide were found to be comparably little, most probably because of the low incident angle of the light rays.
Especially, the idea of building a Lagrangian-type of illumination was found to be very straightforward in order to become independent from the Pitch- and Roll angles of the motorstage.

References
MorphCol Supplement #21 – Intelligente Beleuchtung für AMOR. Unpublished report by M. Knappertsbusch and Marc Chalençon, 7. July 2011), 3 p.
Pdf available under
http://pages.unibas.ch/museum/microfossils/Research/MORPHCOL/SUPPL_21.pdf

Schneider, E. and Chalençon, M. (2012). Machbarkeitsstudie für eine intelligente Beleuchtung für den Abbildungsautomaten AMOR. Student project. University of Applied Sciences (Fachhochschule Nordwestschweiz, FHNW), 14 p. Supervisor: Prof. J. Eisenecker, FHNW, co-supervisor and customer: M. Knappertsbusch, NMB).