Bringing Your Outdated Stereo Microscope into the Modern Age with LED Illumination

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Nearly two decades ago, one of the authors (DR) acquired his first stereomicroscope from a reputable German manufacturer. This compact yet robust microscope faithfully served its purpose over the years. However, as we delved deeper into its use, certain limitations became apparent, hindering its adaptability to specific tasks.

One of the primary limitations of using the microscope is the conventional illumination system, which draws power directly from the electrical mains. Although the built-in AC transformer added stability by reducing vibrations, it confined the microscope's usability to locations close to power outlets. Moreover, the 20W halogen bulbs beneath the microscope stage emitted significant heat, raising concerns. While this setup worked well for brief use or when examining temperature-insensitive specimens like minerals and components, it posed challenges when dealing with live organisms. For instance, a droplet of pond water on a slide would rapidly evaporate due to the heat, endangering the delicate life within. These issues fuelled our quest to discover a modern, readily available solution to both problems, and this article documents our journey. The availability and development of Fused Filament Fabrication (FFF) 3D printing technology have democratized amateur science and microscopy. This technological shift has enabled enthusiasts to unleash their creativity, facilitating the innovation, customization, and adaptation of scientific instruments, such as stereomicroscopes, thereby expanding their versatility and impact.

This article describes the modernization of an aging stereo microscope through cost-effective modifications that can be easily tailored to address similar issues in other models. Upgrading old microscopes with LED technology is a topic covered in other interesting articles in this journal (see, for example, references [1-7]). We hope our contribution, including the use of 3D printing technology, can add a valuable and inspiring contribution to this topic. The article is organized into two distinct sections. The first section outlines replacing the power-dependent illumination systems with rechargeable battery-powered LED lights. In the subsequent section, we delve into converting an inexpensive rechargeable ring LED light, initially designed for smartphone photography, into a practical ring illuminator intended for microscopy purposes.

MODIFICATION OF THE EPISCOPIC AND DIASCOPIC ILLUMINATION

In this project, we utilized a Creality Ender 5 Pro 3D printer, employing 1.74 mm PLA filament for the printed components. The 3D printer was used to build a support bracket for the lighting system. An inexpensive battery-powered LED lamp replaced the original 20W incandescent bulb with multiple LEDs bought in a DIY store (Figure 1A). The chosen variant incorporated white LEDs powered by three AAA-type batteries, featuring a magnet for convenient attachment to metal surfaces.

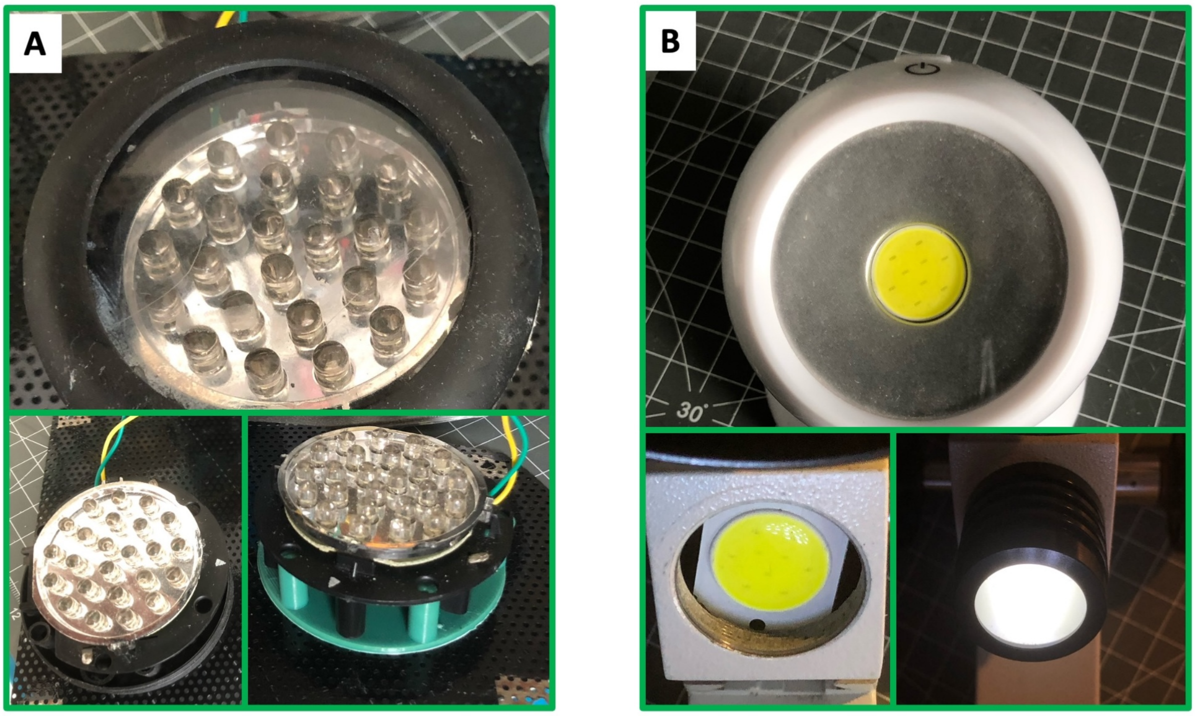


Figure 1: (A) The 24-LED lamp, sourced from a DIY shop, was retrofitted as the primary bottom lighting. The two lower pictures depict the finished retrofitting process. The green support was 3D-printed. (B) The top image displays the desktop spot LED light, the source of the yellow LEDs used to replace the 20W filament light in the microscope's epi-illumination lamp. The two bottom images showcase the completed installation.

The original lighting system relied on a bulb powered by a power supply enclosed within the microscope's base, which required a cable to connect to a power outlet. We aimed to eliminate this dependence on an external power source, making the microscope easily portable. To achieve this, we installed an internal rechargeable power supply that can be recharged without opening the microscope's base. We found an inexpensive and practical solution using a 5 V USB rechargeable power bank. Additionally, we wanted to include a rudimental dimming feature for adjusting the light intensity. To do this, we replaced the original megaohm potentiometer with a linear 10K potentiometer.
The microscope also has a light spot that illuminates the sample with incident light provided by a separate 20 W bulb mounted in the microscope's arm. We have also substituted this bulb with a small LED array recovered from an inexpensive spot lamp (Figure 1B).

A detailed description of these modifications, which includes a comprehensive list of materials and the scripts for generating the file for 3D printed parts, can be found in our project's Instructable page [8]. Here, we will just summarize the construction and some of the outcomes.

The initial task involved the elimination of the power supply circuitry embedded within the microscope's base. Accessing this circuitry required disassembling the base, a process achieved by removing the metallic cover. Subsequently, we detached the power cord from the transformer and dismantled the power supply electronic board. Hence, we could disconnect the dimming potentiometer, the lamp socket, and its associated support. Lastly, the 1 MOhm dimming potentiometer was removed from its position and substituted with a 1 KOhm alternative with a 3D-printed plastic wheel and a supporting bracket.

The LED printed board in the original spotlight is supported by a 3D printed frame that incorporates the original disk magnet for securing the frame to the microscope's metallic grid base plate.

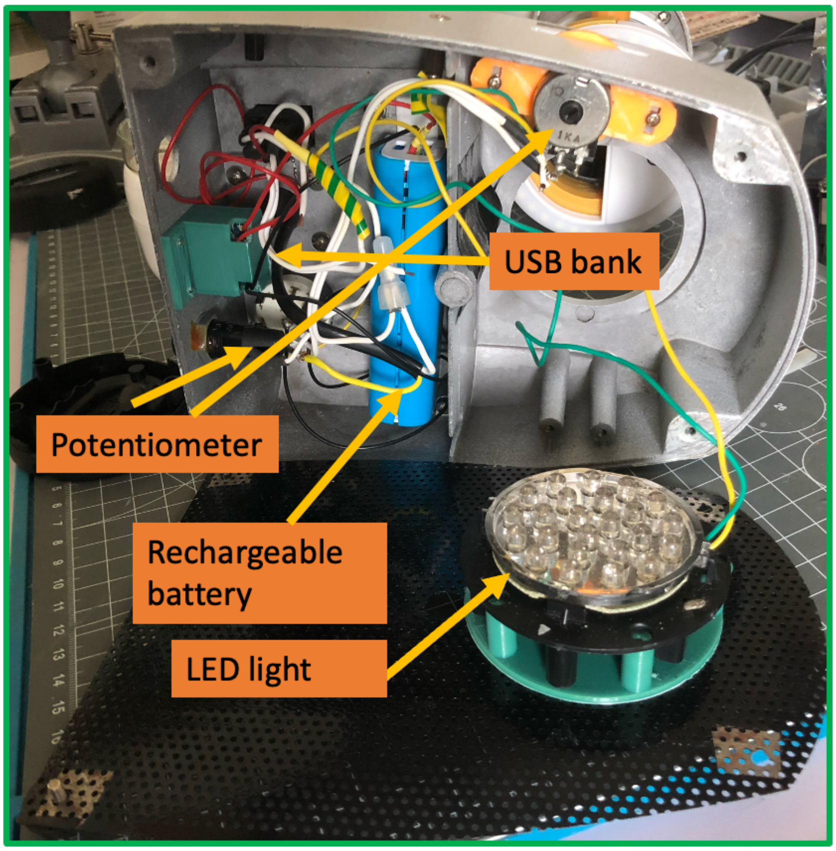


Figure 2: An overview of the modified circuits within the stereomicroscope base, highlighting the various altered components. The LED lights have been securely affixed to the metallic base using a flat Neodymium magnet.

The LED light was powered by the inexpensive rechargeable lithium battery power bank adapted to fit the entrance hole of the original microscope power, allowing access to the recharging USB female socket connection. We modified this by opening the power bank and separating the charging board from the battery. The charging board was placed inside a 3D-printed housing, while the battery remained in its original plastic enclosure, securely positioned within the microscope base frame. With the power bank's USB connection easily accessible, the microscope was poised for seamless recharging (see below).

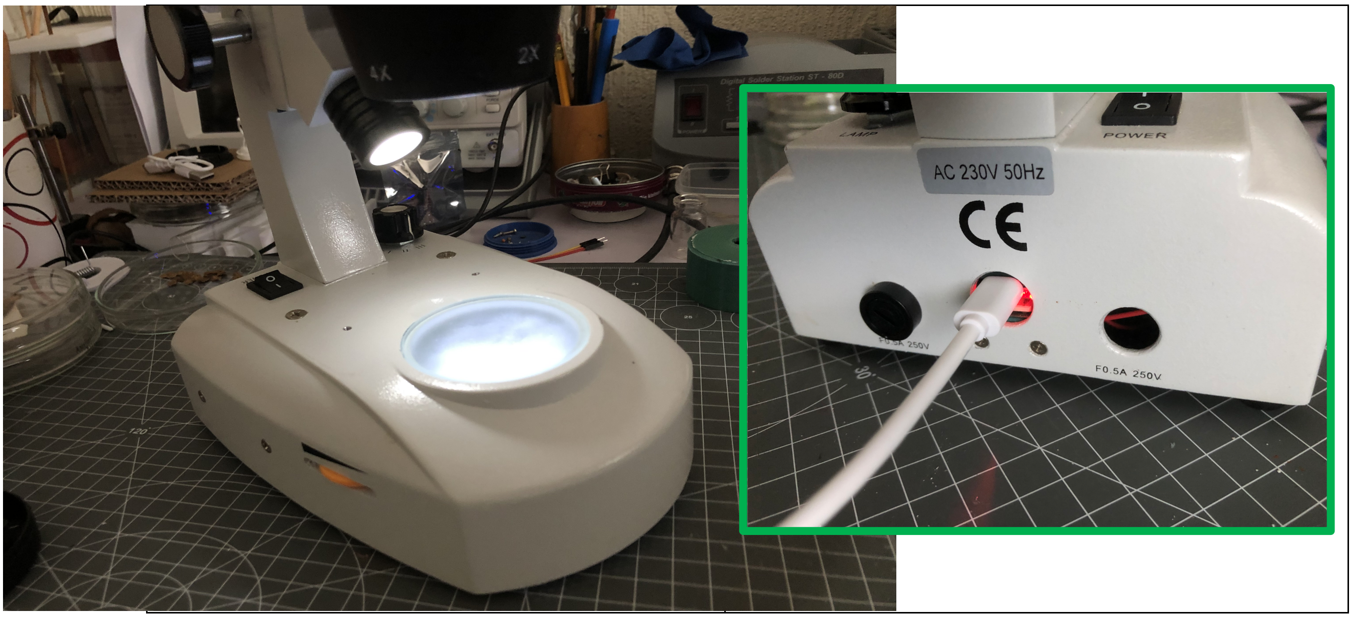


Figure 3: The refurbished microscope retains its epi-illumination feature. While the potentiometer offers some dimming capabilities, it could benefit from further improvements. Its portability and the convenience of quickly recharging the internal power source is an excellent advantage.

Figure 4 shows examples of photos captured with a smartphone at 40x magnification, featuring a tiny spider, a glass fragment, and two foraminifera shells. These images are illustrative examples of the illumination the bottom LEDs provide.

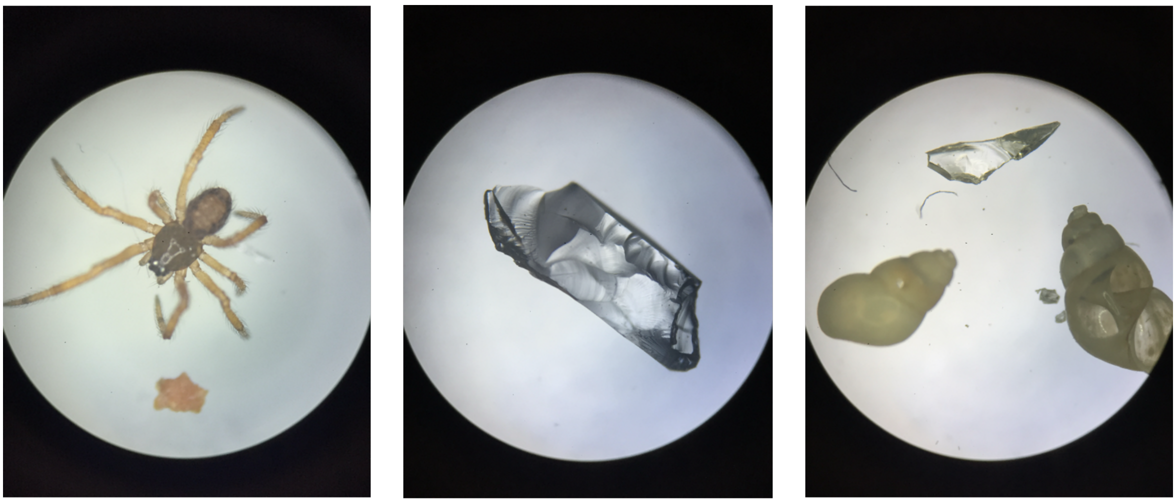
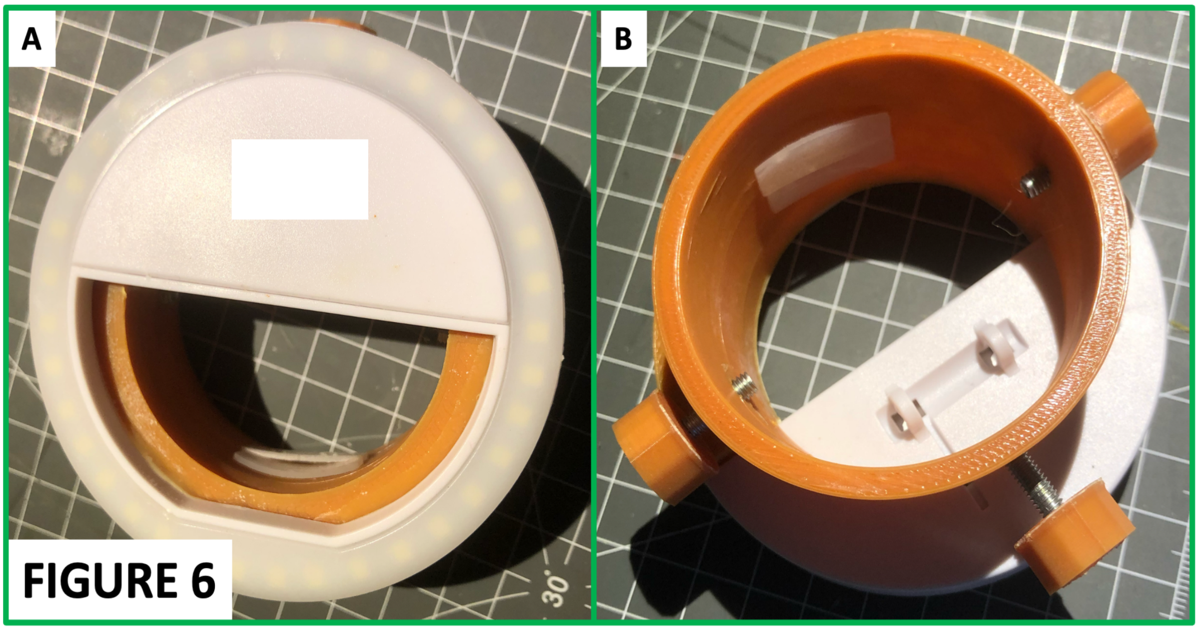


Figure 4: Examples of transmission illumination using the new base LEDs retrofitted to the microscope.

UPGRADING THE TOP ILLUMINATION WITH A BUDGET-FRIENDLY LED RING

The incident illumination system of the microscope, as it beams the light diagonally on the microscope table, does not provide a uniform illumination of the sample. For this reason, it is substituted with a ring of LED attached to the objective. We stumbled upon a UK discount shop chain offering a ring LED illuminator for smartphones. This illuminator includes a rechargeable LiPO battery and offers dimming capabilities with three selectable luminosity settings, all at a very affordable price. This discovery sparked the idea of using it to provide our microscope with a suitable ring illuminator. The LED ring is equipped with a clamp to be attached to the smartphone for capturing portrait photos. We removed the spring clamp and affixed the LED ring to a custom-designed 3D-printed adapter to repurpose this LED ring for epi-illumination. This adapter was carefully created to fit the microscope's cone-shaped



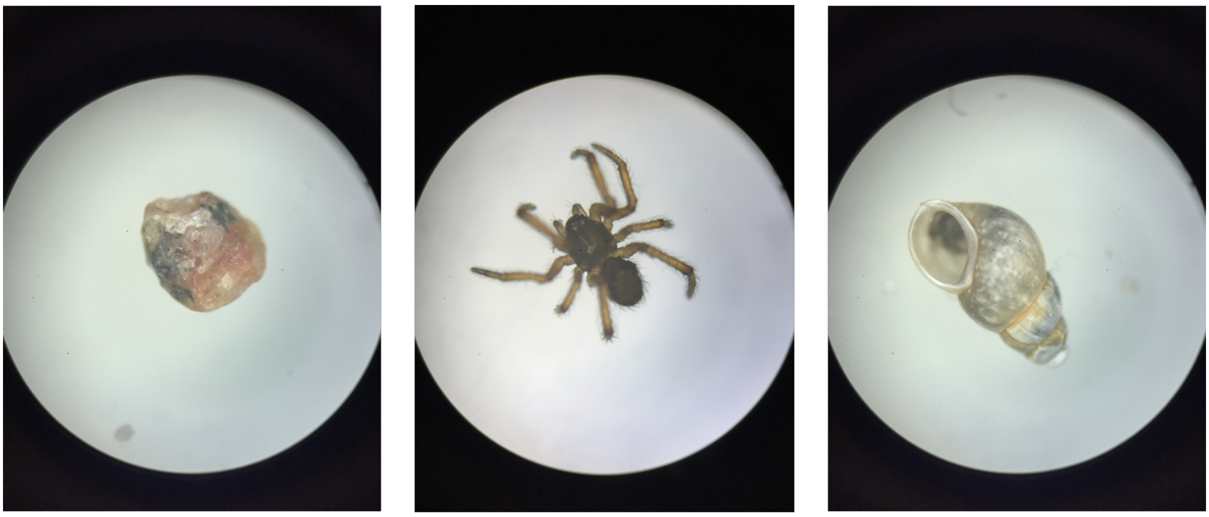


Figure 6: Examples of epi-illumination using the ring LED.

CONCLUSIONS

This article documents retrofitting and enhancing an older stereomicroscope's illumination system using an off-the-shelf, affordable LED lamp. The microscope's portability and functionality have been significantly enhanced by incorporating LED lighting powered by rechargeable batteries and introducing to illumination with an inexpensive LED ring light.
One key advantage of the new illumination system is its freedom from its usual dependence on a power outlet, allowing the microscope to be used anywhere. Using LEDs also eliminates the issue of heating, which can adversely affect observations of live animals or liquids. Furthermore, the cost of materials for these improvements remains cost-effective while providing enjoyment and personal satisfaction.
We hope that this example of modifications can suggest the way to upgrade other models of stereomicroscopes, emphasizing the value of innovation in preserving by upgrading old but still functional scientific equipment.

REFERENCES

1. B. Darnton. Some experimental ideas for adapting the O.U. microscope with a white LED light source. Micscape Magazine. July 1999
2. I. Walker. LED Illumination For Microscopes. Micscape Magazine. May 2004.
3. J. Walsh. The Microscope Lamp. Design Considerations for the Ideal Köhler Illuminator. The white LED as a Microscope Illuminant. Micscape Magazine. August 2003.
4. D. Walker. Exploring the use of cheap LED 'halo rings' for car lamps as multi-mode 'condensers' on an upright microscope. Micscape Magazine. August 2016.
5. P. James. A Simple Halogen/LED Lighting Source Modification. Micscape Magazine. September 2011.
6. G. Matthews. Converting a Projecting Microscope to LED Lighting. Micscape Magazine. March 2018.
7. Michael Stubbs-Race. Replacing tungsten incandescent lamps. Micscape Magazine. August 2018.
8. D. Roccatano and L. Roccatano. New Lights to an Old StereoMicroscope. Instructable Project, Sep 11th, 2022. https://www.instructables.com/New-Lights-to-an-Old-StereoMicroscope/

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