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A test system for safely measurements of cancer-inducing UV-C diodes produced in a simple and cost-effective way by rapid prototyping

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The rapid development of new technologies in the field of light emitting diodes are offering opportunities to explore new applications with shorter wavelengths and higher light output within the UV-C spectrum. To validate new LEDs in prototype applications an adaptive test system is advantageous, which fulfills safety standards and can be rapidly produced in a cost- and time saving way.

This work is focused on an open-source solution for rapid 3D printing of an UV-C radiation measuring device. Especially for research groups or universities which can not afford big safety labs.

The high-energy electromagnetic radiation with wavelengths in the UV-C spectrum damages microstructures. The underlying study for this work focuses on the denaturation of compounds in DNA structures caused by UV-C radiation. This denaturation disinfects micro-organisms but has also a cancer-inducing effect on human cells by direct exposing.

Therefore an important criterion for this test system was to realise this set-up in a way the radiation cannot penetrate to the outside during measurement processes. In order to enable a quick realisation at low cost, a prototype was developed that offers full functionality through 3D printing process. The prototype has a simple, passive cooling device for the LEDs and consists of two interlocking parts. It has been designed to quickly change the diodes and cables. A mechanic fixation point has been built-in for mounting the diodes at a defined distance to the measurement system to ensure repeatable measurements.

A photodiode is used to determine the wavelengths and the light output intensities of the LEDs which will be validated. By using 3D print polymers as the basic structural material, such as ABS, the production of the prototype is very cost-effective and can rapidly be printed.

The setup contains a resistance control system to manually regulate the light output of the diodes and thus prevent the irradiation limits of the sensor diode from being exceeded.

After modeling and printing the prototype a series of tests has shown the functionality of that UV-C Diode test system. First models printed with less than 40 % infill showed a permeability for uv / vis radiation. By increasing the infill up to 50 %, the transmission of light could be prevented and the system worked well. To increase the radiation absorbing effect, the color of the filament used is black.

The measurement results from this experimental setup serve as a basis for research on the disinfection performance of different UV-C diodes.

Used material & components:

Polymer:	ABS (Black), 1,75 mm, PrimaValue
Tests ensor:	Ocean Optics USB 2000+
LEDs:	SZT LED 5 V UV-C 250 nm, 260 nm, 270 nm, 290 nm, 300 nm
Electronic:	RK09K113-LOG10K, rotary potentiometer, mono, 10 kOhm
3D Printer:	Makerbot Replicator X2
Print Density:	50 % infill

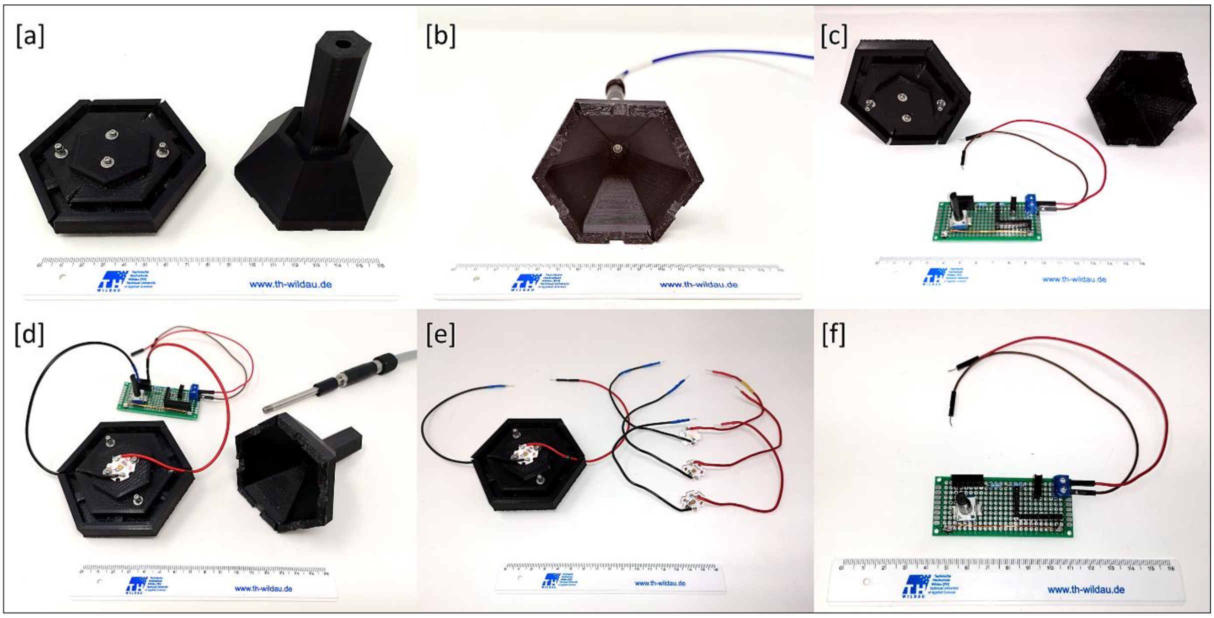

Figure 1: Photographs of the 3D printed test system for measuring UV-C radiation in a safe application. Picture [a] shows both parts of the 3D printed model [Fig. 2]. [b] shows the upper part with sensor (Ocean Optix USB 200+). [c] [d] Show electronic components used to operate the UV-C-LEDs [e]. [f] shows an example of measurement curves of 2 UV-C LEDs with that system.

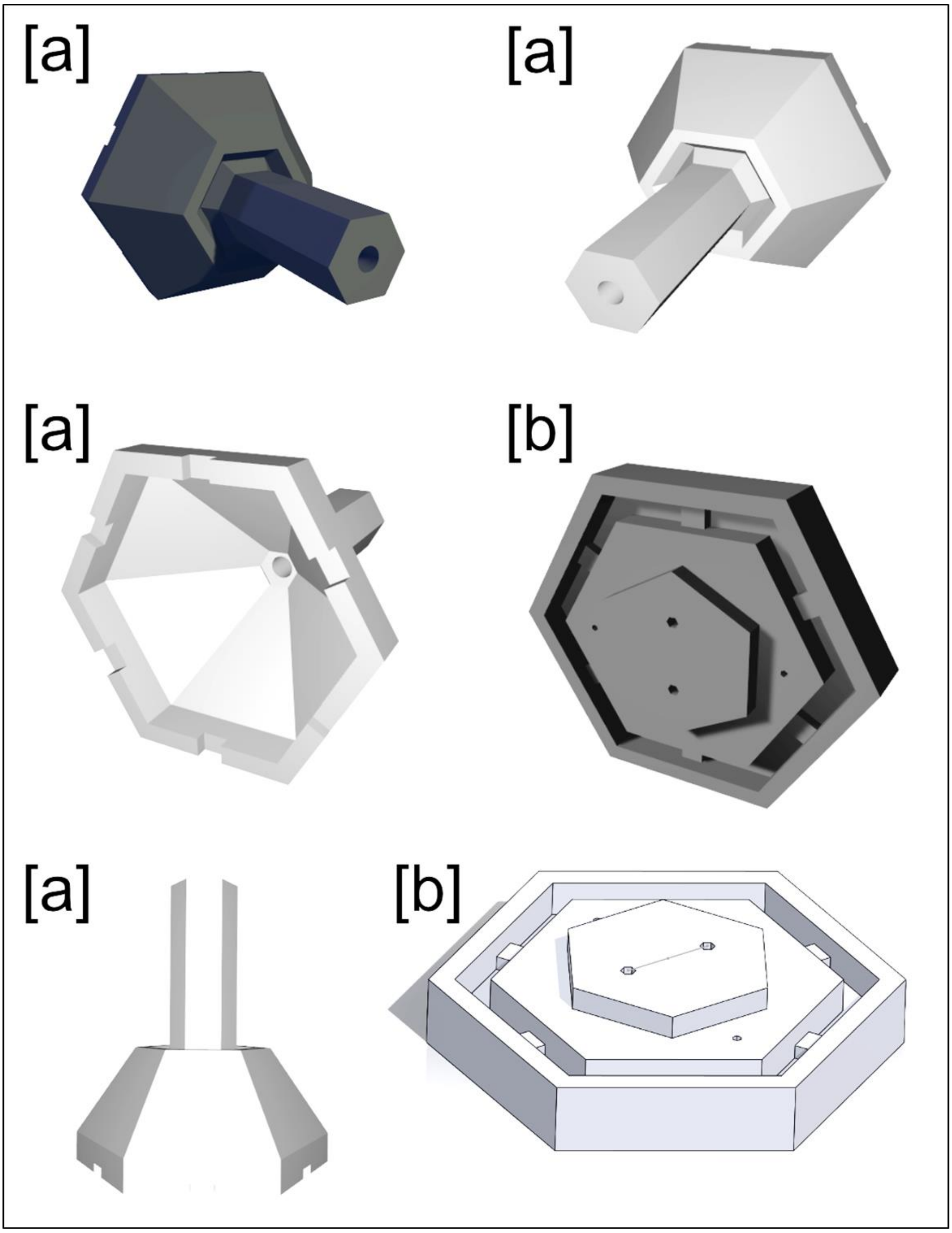

Figure 2: CAD models for 3D printing of this measuring system for UV-C radiation. The top part [a] and the bottom part [b] are shown.

Underlying and related material

Both CAD files are available on https://nextcloud.th-wildau.de/nextcloud/index.php/s/RXNETZrf7CAQinp.

Competing interests

The authors declare no competing interests.