SolDis-1 Reactor 5 Open Source 3D Printed Solar Powered UVC-LED Water Steriliser

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Abstract

The United Nations has declared that access to clean water is a human right (Www.un.org, 2014). Traditional ways for sterilising water include mercury Ultra Violet (UV) lamps and chlorine based solutions (Guerrero-latorre, 2016). Advances in Light Emitting Diodes (LED) technology and the availability of quartz glass for refracting the UV light(Song, et al, 2016) have led to low cost UVC-LEDs that can be imported from China or can be obtained commercially in Europe and the USA.

Open source microcontrollers such as the Arduino (D'ausilio, 2011) are programmable, low cost and easy to use portable computers with a large online community.

Solar power technology has also come down in price and this paper presents a novel 3D printed solution for sterilising water using plastic soda and water bottles that have a standard 28mm screwcap mechanism(A G Barr, 2018).

Plastic pollution is a global problem and the SolDis-1 Reactor 5 UVC LED solar powered water steriliser prototype is a method for recycling disposable plastic bottles (Plasticpollutioncoalition.org, 2018) . The prototype is based on the patent filing for a solar powered uvc led water steriliser by the author(Ipo.gov.uk, 2017). We briefly discuss in the conclusion attaching the apparatus to robotic autonomous systems. Special thanks to Solidworks (Solidworks.com, 2019) for sponsoring the development of the Soldis-1 Reactor 5 prototype.

Introduction

The paper covers how to acquire the parts, the tools required, production and assembly. The paper does not cover testing. The papers objective is to demonstrate the manufacturing process and a framework for the UVC-LED reactor sterilisation process by demonstrating the production of a viable UVC-LED reactor chamber for the purpose of sterilising contaminated water, portably, at source. The prototype can be manufactured using other appropriate materials and the paper presents a 3D printed solution as it is relatively easy to order a print online.(3dprint-ukcouk, 2019)

The prototype demonstrated in this paper was printed at the Steamhouse, Digbeth.(Steamhouse.org.uk, 2018) 3D printers can cost as little as £150 and as much as tens of thousands of pounds. 3D printers are available to purchase online. Website links for the parts and tools will be listed in the parts list section.

The UVC-LED was ordered from the Alibaba website and the 7 volt solar powered battery was ordered from ebay. The Arduino Uno microcontroller was ordered from Amazon and is widely available. Weblinks are supplied in the parts list section of this report.

Graphene oxide membranes also offer the prospect of quick and low cost methods for desalination (Rincon, 2017) and filtration. We propose in the conclusion the use of graphene membranes as a water filtration system prior to exposing the contaminated water to the uvc-led light in the reactor chamber.

Finally, Quartz glass sheets are required to refract the UVC light in the 3D printed reactor chamber.

Parts List and Tools

Arduino Uno
https://www.amazon.co.uk/Elegoo-Project-Starter-Tutorial-Arduino/dp/B01D8KOZF4/ref=sr_1_3?ie=UTF8&qid=1548201877&sr=8-3&keywords=arduino

7 Volt Solar Panel
https://www.ebay.co.uk/itm/231103792303

2 x UVC-LEDs
https://www.alibaba.com/product-detail/High-Power-SMD-3535-UVC-275nm_60795139460.html?spm=a2700.galleryofferlist.normalList.126.77ed2d93NvBijy

Black and red insulated electrical wire
https://www.amazon.co.uk/8-Wire-Colored-Insulation-Wrapping-B-30-1000/dp/B075LTMNHY/ref=sr_1_12?ie=UTF8&qid=1548202224&sr=8-12&keywords=electrical+wire

Arduino UNO linker shield
https://www.ebay.co.uk/itm/New-Base-Sensor-I-O-Shield-Expansion-Board-Module-For-Arduino/272156148965?hash=item3f5dc544e5:g:i30AAOSwBfhbzZwx:rk:26:pf:0

LED Linker Pack
https://www.ebay.co.uk/itm/5mm-Linker-LED-Pack-For-Arduino-pcDuino-Low-power-Red-Yellow-Blue-Green-LEDs/153270635109?hash=item23afa44a65:g:-kYAAOSw7PJb9Wpj:rk:1:pf:1&frcectupt=true

Soldering iron and solder
https://uk.rs-online.com/web/c/tools/soldering-desoldering-tools/soldering-irons/

G – Clamps
https://www.ebay.co.uk/itm/3Pc-Mini-G-Clamp-Grip-Set-Small-Screw-C-Clamps-25mm-50mm-75mm-Wood-Metal-Work/183271855068?hash=item2aabda93dc:g:EyQAAOSwcF1bIPGc:rk:2:pf:1&frcectupt=true

3D Printer and filament (optional)
https://www.amazon.co.uk/XYZ-Printing-miniMaker-printer-assembled/dp/B01KVJCXWM?SubscriptionId=AKIAIPHVZTVH6LZ5BFZA&tag=hawk-future-21&linkCode=xm2&camp=2025&creative=165953&creativeASIN=B01KVJCXWM&ascsubtag=trd-9818819581856757286-21

Insulation tape
https://www.amazon.co.uk/s/ref=nb_sb_noss_1?url=search-alias%3Daps&field-keywords=insulation+tape

2 x 28mm Screw top plastic bottles (empty standard 500 ml water or soda bottle)

2.1 mm DC Power plug
https://www.amazon.co.uk/MAPLIN-2-1mm-Screw-Terminal-Power/dp/B007PZNGYA

Computer or smartphone connected for downloading .STL files

30mm x 30mm Quarts glass sheets
https://www.amazon.co.uk/ChaRLes-Double-Polished-Silica-Quartz/dp/B07JN2CHN4/ref=sr_1_1?ie=UTF8&qid=1548117305&sr=8-1&keywords=30mm+quartz+sheet

Silicone Sealant
https://www.ebay.co.uk/b/Silicone-Sealer-Home-Adhesives-Glue/131625/bn_9522527?_trksid=p2045573.m2388

3D Printing the STL files from the GitHub Repository

Enter the following url into an internet connected browser:
https://github.com/ionnur/SolDis_Reactor5

Download the zip file and extract the contents. The STL (Bethany, et al, 2014) files are required for the 3D printer to print the housing and standard 28mm screw top adapter for connecting the plastic bottles to the reactor.

Online 3D printing houses offer many bespoke services and only require emailing of the STL files for printing.

3D printers can be obtained from the internet or specialist stores.

Once printed the 30mm by 30mm slots should be clean allowing for easy insertion of the 30mm by 30mm quartz glass sheets.

Soldering the 2.1 mm Adapter and preparing the UVC-LEDs for connection to the Arduino.

The SolDis-1 Reactor 5 requires some soldering and modifications to the 7 volt solar panel DC connector.

Cut the power supply connector, that connects to the hunting camera, and solder the 2.1mm DC Power plug onto the exposed cut wires for connection to the Arduino Uno.

Cut and remove the LED from the LED linker. Solder the black and red wires observing positive and negative conventions.

Solder the other end of the exposed black and red insulated wires to the UVC-LED pad, negative to negative and positive to positive observing correct conventions for anode and cathode. Use the G Clamp to hold the parts in place

Wrap the wires with insulation tape leaving only the UVC-LED light exposed and covering the wires to the linker.

The solar panel and the two UVC-LEDs are now prepared for assembly and placement over the quartz glass windows which will be placed into the slots of the 3D printed reactor housing.

Assembly

Connect the linker unit to the Arduino. Connect the UVC-LEDs to the linker. Connect the solar panel with DC power cable to the Arduino.

Slide the 30mm by 30mm quartz glass sheets into the top and lower reactor 3D printed pieces.

Apply silicone on the exposed surface side of the quartz glass (Figure 1.0) around the edges only, leaving the centre of the quartz glass free of silicone for direct refraction of the UVC LED light into the chamber. Secure the UVC-LED in place on the quartz glass with insulation tape.

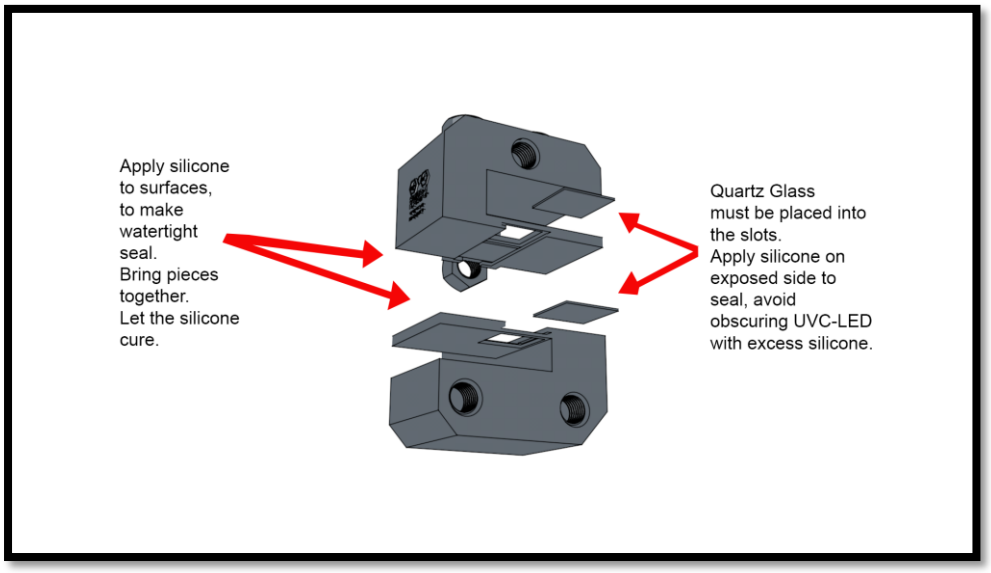


Figure 1.0 SolDis-1 Reactor 5 assembly and where to apply silicone sealant

Assemble the SolDis-1 Reactor 5, see Figure 1.0, applying silicone to all touching surfaces in order to make the unit water tight.

Screw down the joining plate after applying silicone to the touching surfaces , see Figure 2.0, whilst making sure excess silicone does not obscure access, for the water, to the reactor chamber.

Attach both 28mm adapters.

Allow the silicone to cure before proceeding.

Gather water into one of the plastic bottles for flow testing and water tightness and attach both plastic bottles to the fully assembled unit.

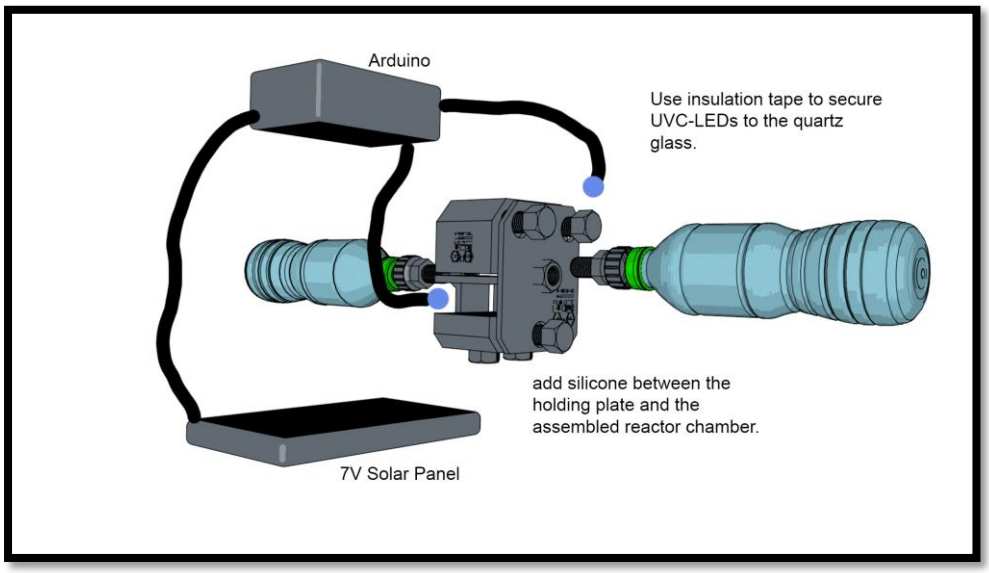


Figure 2.0 fully assembled Solar powered UVC-LED Water Steriliser

Conclusion

The paper demonstrates a method for making a solar powered UVC-LED water steriliser. The original patent added blue-tooth connectivity for remote control of the UVC-LED light.

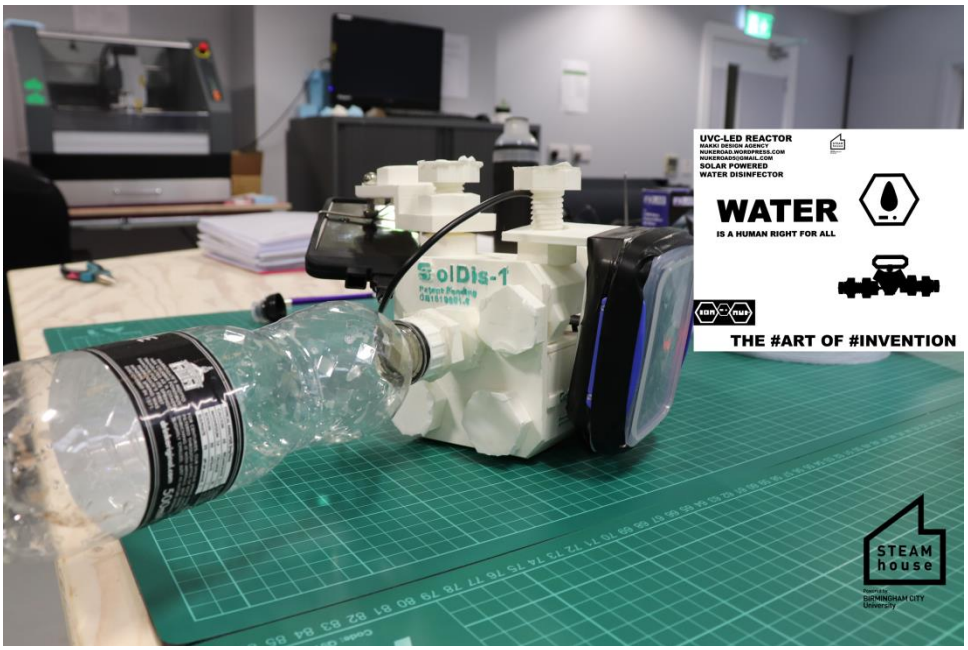
Graphene membranes can be added to the 28mm threaded adapter in order to remove grit and desalinate the water contained in the plastic bottles prior to exposure in the reactor chamber..

This further enhances the reactor as it adds two levels of water purification. Liquid Phase Exfoliation is explained by Robert Murray-Smith (Murray-Smith, 2014) on his Youtube channel and offers an entry level procedure for synthesising graphene from graphite powder.

Creating graphene on an acetate substrate for creating the filters requires a Lightscribe DVD burner and applying graphite oxide in solution to an acetate substrate (El-Kady et al., 2012) This method offers an introduction for exploring graphene filtration systems.

Plastic pollution is a major global problem and the SolDis-1 Reactor 5 makes recycled 500 ml 28mm screwtop disposable plastic bottles useful reservoirs for disinfecting water across the world.

The open source SolDis-1 Reactor 5 and software is released under the MIT license as a proof of concept for further development, including attaching the apparatus to a drone for remote collection or analysis, where a potential water supply is in a hard to reach or remote location.



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Moysha 'Big Stygs' Shepherd - http://www.suspectwear.com/

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