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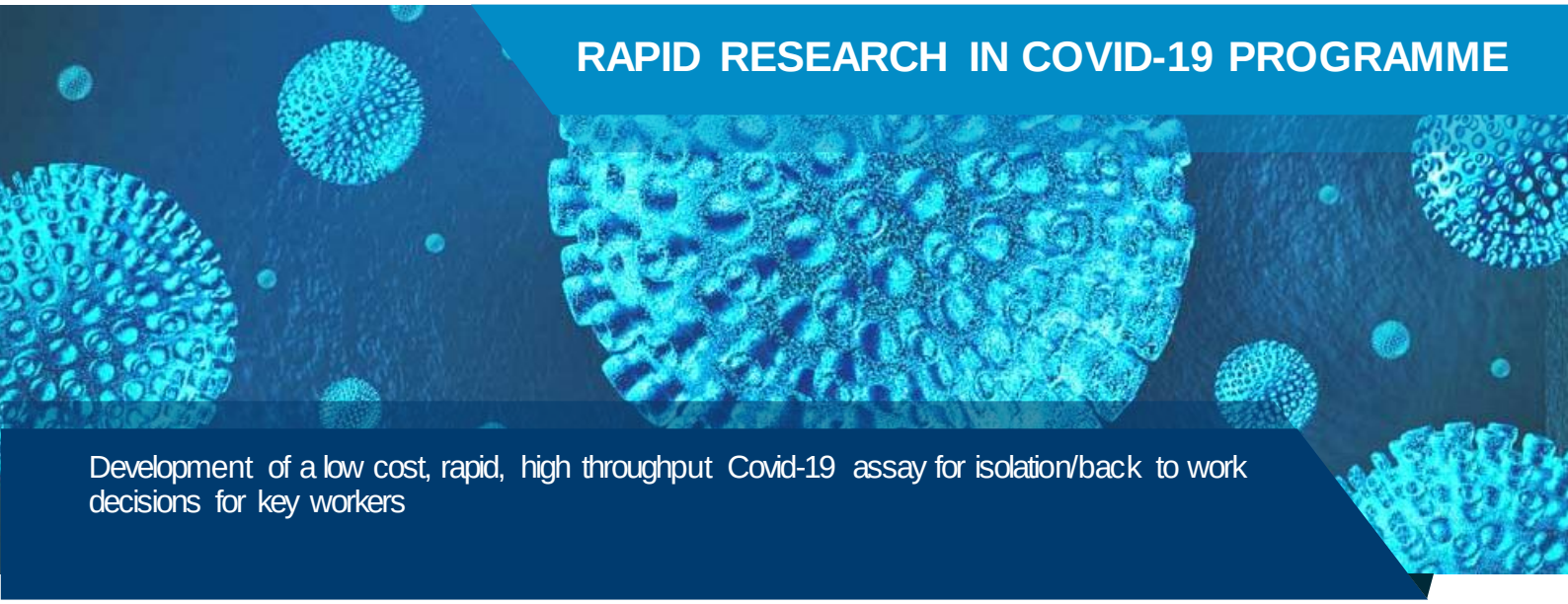
# RAPID RESEARCH IN COVID-19 PROGRAMME



Development of a low cost, rapid, high throughput Covid-19 assay for isolation/back to work decisions for key workers

## AIMS

The outbreak of COVID-19 has led to the use of social restrictions to prevent spread of the infection. In anticipation of a second wave during late 2020, this project aimed to develop a low cost, highly manufacturable test capable of detecting the virus in saliva in the hope it would help with reopening the economy and reducing spread of the infection amongst in particular healthcare workers.

## KEY FINDINGS

- It was possible to design a sensor which could detect as few as 40 copies of the virus which is sensitive enough for use in the field (a viral load of around 10,000 copies/mL estimated in low viral load patients).
- The sensor was designed for use in saliva.
- The design of the sensor means it can be produced in high volumes and at very low cost.
- Detection was possible within 30 minutes with significant scope for reduction of result time.

## WHAT DID THE STUDY INVOLVE?

The project involved the design and development of a prototype rapid test for COVID-19. A number of partners were involved including: University of Strathclyde, FlexMedical Solutions, NHS Greater Glasgow and Clyde and Lifescan Scotland (a major manufacturer of diabetes test strips). The developed sensor took its inspiration from the diabetes test strip because these products can be manufactured in high volume (20 million test strips per day or 8 billion per year) and at low cost (<20 pence each). One of the project partners, Lifescan Scotland are a world leading manufacturer of diabetes test strips which measure blood glucose levels and the technology produced therefore had upscaling in mind.

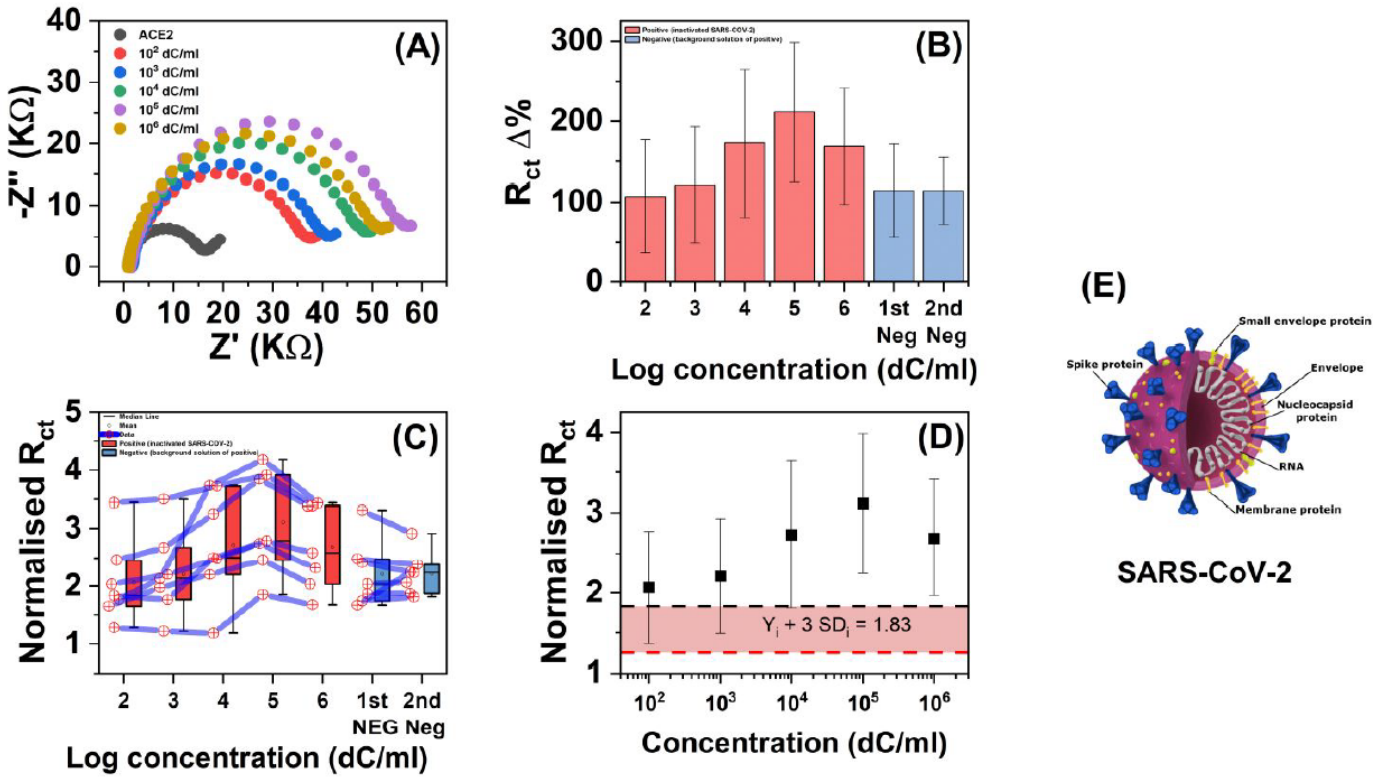
To develop the test it was necessary to test a number of biological receptors for COVID-19 as potential approaches to detecting the virus. DNA, antibody and enzyme based sensors were all tested at the beginning because these all measure different aspects of the virus, e.g. its genetic sequence or the proteins present on its outer coat. It was also necessary to test a series of chemical treatments to be applied to the gold sensor surfaces of the testing strip to make these strip surfaces hydrophobic (water resistant) and hydrophilic (water attracting).

## WHAT WERE THE RESULTS AND WHAT DO THEY MEAN?

We found that of all the biological receptors which could be used to detect the virus (e.g. antibodies, DNA, RNA and enzymes), by far the most effective sensing element was the enzyme called "Angiotensin Converting Enzyme 2" or ACE-2. This happens to be the enzyme which COVID uses to attach to and enter the cells of the upper respiratory tract. Enzymes carry out many functions in the body and ACE-2 has a role in regulating blood pressure. The fact that the virus binds so intimately with this receptor is no surprise since it uses ACE-2 to enter cells. The fact that the ACE-2 enzyme could be used as the viral detector was another boost to the project. This is because glucose home blood sensors used for monitoring diabetes, use an enzyme (called glucose oxidase) to detect glucose and so it would be possible to use diabetes strip manufacturing techniques to spot ACE-2 onto gold sensors rather than glucose oxidase, as is the case for diabetes sensors.

We found several of the commercially available antibodies to be sub-optimal for detecting the virus. Again the fact that the ACE-2 enzyme showed the best behaviour as a COVID detector molecule and was also compatible with existing manufacturing approaches for these type of sensors, was a very satisfying finding. It was also found that the ACE-2 enzyme could be loaded onto the sensor highly effectively when the gold sensor surface was covered with a special hydrophobic coating.

The test as developed was able to detect as few as 40 copies of the virus, which was well above the typical levels of virus particles in a saliva sample of a COVID-19 patient. Some summary results are shown below which were gained using inactivated virus samples and show that the virus could be detected successfully and that negative samples did not cause appreciable signal changes. When the technology was evaluated in clinical samples we achieved a sensitivity of 78% and specificity of 75% which is comparable with lateral flow test and our devices will cost considerably less (£5 for lateral flow vs 20 pence for the proposed test strips).




## WHAT IMPACT COULD THE FINDINGS HAVE?

The team have a patent for the technology which is centred on the method of making the gold test strip surface hydrophobic and then loading on the ACE-2 enzyme to detect the coronavirus. Commercialisation and translation opportunities were explored for the technology and this culminated in the formation of a spinout company called Aureum Diagnostics who will commercialise the test. This means that in the future patients will directly benefit from the research project by having access to the commercialised version of the test for rapid diagnosis in the field. In addition, the findings of the project and connections made allowed the PI to become involved in a BBSRC Transformative Research Technologies proposal with Professor Glenn Burley (University of Strathclyde – Pure & Applied Chemistry) which was successfully funded, resulting in an 18 month award of approximately £145,000 to develop new surface chemistries which can be used to produce diagnostic tests and biosensors for respiratory viruses.

## HOW WILL THE OUTCOMES BE DISSEMINATED?

We have published a manuscript in a peer reviewed journal (Chemical Communications). A patent has been filed which centres on the sensor surface coating and method of applying ACE-2 to the sensor surface. The project team will also disseminate the findings at academic conferences, with the PI already delivering an invited keynote presentation. Following acceptance of the first paper through peer review, the PI has engaged with the University Press Office to produce some publicity materials on the project and these were released during 2021 and gained significant attention in both the mainstream and scientific media.

## CONCLUSION

The research team developed a sensitive and fast test for COVID-19. Crucially the test has two simple manufacturing steps, 1) production of a hydrophobic sensor surface and 2) attachment of ACE-2 enzymes to detect COVID-19 meaning that a large number of sensor strips can be produced at significant scale using the production techniques currently employed to produce home blood glucose monitoring technologies for diabetes patients. This will enable the high volume production of a COVID-19 test, which can be used in conjunction with existing diabetes home blood monitoring technologies in the community and by non-specialist staff.

Beyond this period of funded research, the team intend to continue the development of their COVID-19 test through existing PhD students, formation of a spin out company and sourcing of follow on research grants.

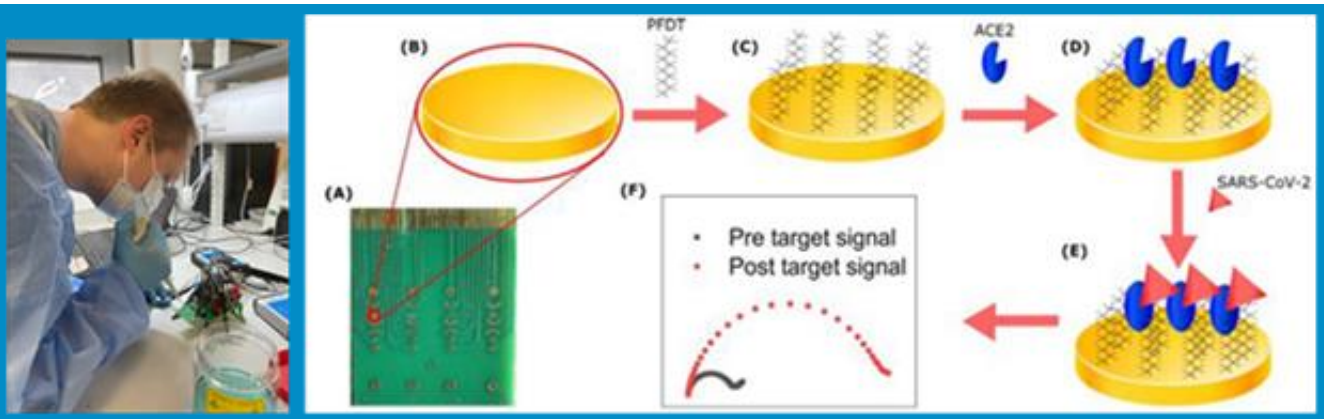



**Image of the test setup (left) and (right) the sensor chip (A) and depictions of the gold sensors for detection of the virus (B-E) and electrical signal (F)**

## RESEARCH TEAM & CONTACT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## ADDITIONAL INFORMATION

Project ended on 16th of March, funding awarded - £142,808.00