Funded projects, NSERC Alliance-COVID19 grants (50000 $ / 1 year)

QCAM member is PI

Marta Cerruti (McGill)

Anti-viral fabric coatings for high effectiveness personal protective equipment (Covid-19)

Industrial partner: H L Blachford Ltd.

SARS-CoV-2 spreads by inhalation or by mucous contact with virus-contaminated droplets. In addition to social distancing, masks and gloves have become increasingly recommended not just for healthcare and essential workers but also for the general public. High-efficacy masks (e.g. surgical masks or N95 masks) and medical gloves, while effective in limited duration, cannot be produced at scale for the whole population and health care providers from all over the world have made desperate pleas to secure adequate supplies of personal protection equipment (PPE).

Here we propose a series of antiviral coatings to be applied easily and stably to fabric. The coatings would kill the virus upon contact, and could be applied both by healthcare workers on low-efficacy masks to make them equivalent to N95 masks or higher, and by the general public, on scarves or gloves that they may already own. The coatings would thus minimize infections through both droplet inhalation or hand-to-face transmission. The coatings we propose are inexpensive, scalable, nontoxic, easy to deposit and will have long-lasting antiviral effect. Blachford Ltd is a world leading chemical material producer with great expertise in formulation of suspensions, thickeners, and dispersions. They are our partner as they are highly interested in our approach and in the commercialization of our results. During this project they will provide both scientific input on coating formulation and regulatory and marketing consultations: while working on the chemistry of the coatings and testing them for antiviral properties, we will understand the regulatory requirements that coatings will need to comply to, and the marketing/production constraints. This fully integrated approach that includes scientific development, production vision and regulatory understanding will allow us to deliver a product that can be brought to the public very soon. This is crucial given the urgency of the pandemic and the benefits that the proposed coatings will bring to the population in terms of being able to go back to a less restricted life, and to the healthcare workers as a way to solve the current drastic shortage of PPE.

Sylvain Cloutier (ÉTS)

High-volume electrospinning of high-performance cellulose membranes required for N95-grade mask fabrication

Industrial partner: KWI Kunststoffwerk Industrie Inc.

This project was highlighted in the ÉTS scientific news

COVID-19: Fabrication of autonomous flexible hybrid electronic devices for patient monitoring

Industrial partner: Varitron Technologies Inc.

Jesse Greener (U. Laval):

Live viral spectroscopy for rapid Covid-19 detection applied directly to clinical biofluids without sample processing

Industrial partner: Bruker Ltd.

Prof. Greener explains: “Currently, the only viable early diagnosis of COVID-19 is based on nucleic acid-based technologies. In contrast, antibody detection by serological technologies is not appropriate for early detection. Infrared spectroscopy is a well-known analytical chemistry technique that can be applied to proteins, nucleic acids, lipids and other bio-macromolecules. Since viruses, such as the SARS-CoV-2, are composed of these basic building blocks, they will generate a unique spectral fingerprint that can be exploited for diagnostics applications. As such, IR spectroscopy has already been proven for viral detection in unpurified liquid blood samples and even live infected cells.

We intend to leverage new patent-pending microfluidic assaying accessory for a high-throughput infrared spectroscopy-based early detection of SARS-CoV-2. Our partnership with world-leading spectroscopic analytical manufacturers, Bruker Ltd., will maximize our chances of developing a turnkey system based on the new technique we call “live viral spectroscopy”.

Véronic Landry (U.Laval):

Development of dual-action antiviral coatings against COVID-19.

Industrial partners: CANLAK, EMCO-INORTECH

Prof. Landry’s group tells us more about the project: “Wood creates a comfortable atmosphere indoors, thus contributing to the occupants’ wellbeing. However, it is very seldom used in the interior design of public and commercial buildings, despite its highly valued aesthetic appeal and its environmental qualities. Moreover, routine care and excessive wear of wooden surfaces pose significant challenges that limit a more widespread use of this material. The current pandemic has also heightened the need for antiviral surfaces. Against this backdrop, this project aims to develop high-performance, industrially viable antiviral coatings. The novel coatings will be intended for “high touch” surfaces in commercial and public buildings (hospitals, shops, schools, etc.), i.e. surfaces with frequent hand-contact entailing an elevated risk of contamination and transmission of the SARS-CoV-2 virus. These coatings will be applied to mural panels, doors and other decorative wooden products, but also to metallic or plastic substrates”.

Gaétan Laroche (U. Laval)

Functionalising materials surfaces with antiviral molecules: an approach to limiting the transmission of COVID-19.

Industrial partner: Avmor Ltd.

"This partnership brings together Prof. Laroche, a specialist in surface engineering, and AVMOR's know-how, a leading company in safe cleaning solutions. AVMOR's products are particularly intended for customers who need to carry out effective disinfection of high-touch surfaces: restaurants, grocery businesses and catering firms. Prof. Laroche and AVMOR thus join forces to develop materials featuring a surface permanently resistant to contamination by bacteria and viruses (such as that causing COVID-19). Evidence shows that soap is effective in eliminating the COVID-19 virus: for this reason, the strategy adopted in this project aims to mimic the mechanism of action of soap molecules. On contact with polymer or metal surfaces modified with covalently bound amphiphilic surfactant molecules, the membrane of COVID-19 and similar viruses will be destroyed, thus inactivating the virus"

We emphasise that this project is a partnership between a regular and an industrial QCAM member.

Gelareh Momen (UQAC)

Design, characterize and validate a new multifunctional coating, with antiviral and antibacterial properties for COVID-19 pandemic

Industrial partner: NanoPhyll Inc.

Prof. Momen refers to this research project in an interview to the newspaper *leQuotidien*. She explains how one can draw inspiration from nature, in particular from lotus leaves, to develop novel self-cleaning surfaces.

Phuong Nguyen-Tri (UQTR)

Preparation and evaluation of the biological activity of antiviral agents based on copper and silver oxides used in personal protective equipment [PPE] *against SARS-CoV-2 (COVID-19)*.

Co-applicant: Gelareh Momen (see above).

Industrial partners: NanoBrand; Tekna Plasma Systems Inc.

In order to carry out his research on materials for PPE, Prof. Nguyen-Tri will also receive a major grant (120 k$) from the Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST). In addition, some Mitacs-Accelerate fellowships (total value 135 k$) will allow students to join Prof. Nguyen-Tri's lab for an internship and help with the research on materials for PPE. Last but not least, Prof. Nguyen-Tri was also appointed UQTR Research Chair in materials for health and safety at work earlier this year.

Federico Rosei (INRS)

Prof. Rosei gives an overview of his three funded projects:

Plasmonic optical biosensor for COVID-19 detection

Industrial partner: Maxwellian Inc.

Prof. Rosei's team at INRS and Maxwellian decided to join efforts to develop a technology for antimicrobial sensing and specifically COVID19 detection, adapting Maxwellian's existing sensing technology for this purpose. Maxwellian brings its core expertise in optical fiber sensors and its technology based on photonic-plasmonic resonators to synergistically combine it with developed nanomaterials and processes that comes from this project. The success of this project will contribute to advance knowledge in biosensing and will enable our industrial partner to develop a commercially competitive technology and new products based on optical sensing, superior to current electronic sensor technologies.

Photoelectrochemical biosensing for COVID-19: virus and antibodies

Industrial partner: Solstar Pharma

This project aims to develop an efficient antibody sensor, as preventive measure for detection of infections caused by COVID19. It addresses a problem of crucial importance for Canada and for Solstar Pharma, a Canadian company that focuses on research & development of antimicrobial, anti-viral and anti-cancer agents for the treatment of life-threatening diseases. Our objective is to develop a Photoelectrochemical (PEC) biosensor based on photoactive nanoparticles such as Quantum Dots (QDs) for the detection of COVID19 and related antibodies. Highly efficient QDs based on engineered core/multi-shelled structures will be developed and their interaction with the molecular recognition element (MRE) layer will be investigated. The expected impact and outcome will be the realization of a PEC biosensor for detecting COVID antibodies. In particular, the final miniaturized, low-cost and highly sensitive biosensor will have a major positive impact on Canada's health sector and economy.

COVID-19 Prevention: Hybrid Polymer/Photoactive Ceramic Self-Disinfecting Coating

Industrial partner: Bioastra Technologies.

This project aims to understand and propose a practical solution to prevent transmission of COVID-19 from contact with contaminated surfaces. It addresses a challenge of crucial importance for Canada and for Bioastra Technologies, a Canadian company specialising in smart materials for health, robotics and environmental applications. The objective of this project is to functionalize various types of high-contact surfaces with a spray that creates a durable leave-on coating to inactivate COVID-19 and other viruses. We will develop a composite based on Bioastra's proprietary sol-gel formulation integrated with metal-oxide nanoparticle (NPs)-based photocatalysts. We anticipate a synergist effect arising from the antiviral properties of photocatalyst materials combined with the intrinsic virus-inactivating properties of certain charged polymers and their ability to form a durable, fast-setting film when sprayed on a surface. The expected outcomes will result in advancing knowledge regarding the mechanism of virus inactivation on photoactive surfaces. We anticipate that the final spray-coating product will have a major positive impact on Canada's health sector and economy.

Mohamed Siaj (UQAM)

Covid-19-Aptamer development as new diagnostic platform to increase drastically the number of testing by capita

Industrial partner: Azure Biosystems.

QCAM member is co-PI

Theo van de Ven (McGill) *and* ***Roger Gaudreault (UdeM)***

- with PI Normand Mousseau (UdeM)
  Prevention of SARS-CoV2 (COVID-19) related CoV spike protein neuroinvasion and -induced respiratory distress by polyphenols.

  Industrial partner: Fruitomed Inc.

- with PI Charles Ramassamy (INRS - Centre Armand-Frappier)
  Inhibition of TMPRSS2 and 3CL Proteases by natural polyphenols to prevent SARS-CoV-2 infectivity and replication.

  Industrial partner: Fruitomed Inc.

Dr Gaudreault gives us an overview of the context of the research and of its aims:

SARS-CoV-2: Multidisciplinary Research in Green Chemistry

"For several decades, certain food compounds have been recognized as our allies for health; this is the case with polyphenols.

Polyphenols are bioactive molecules naturally present in fruits and vegetables, and more particularly in abundance in dark berries. These bioactive molecules have antioxidant properties and are beneficial for health.

Could it be that these natural chemicals could slow the spread of SARS-CoV-2, which causes COVID-19?

This is the question examined by a multidisciplinary team of researchers, supported by NSERC, whose professors Normand Mousseau (Université de Montréal), Charles Ramassamy (INRS-CAFSB), Theo van de Ven (McGill), Steve Bourgault (UQAM), Kokou Adjallé (INRS-ÉTÉ), Roger Gaudreault invited researcher at Université de Montréal, and Fruitomed Inc.

To answer this, researchers will evaluate the power of polyphenols to inhibit interactions between SARS-CoV-2 proteins and receptors on the surface of cells in humans, as well as to attenuate the process of viral replication that takes place inside human cells. They are based on multidisciplinary approach both on molecular modeling methods and experiments allowing the visualization of polyphenol-protein complexes. These results will open up multiple perspectives booth for the study on neuro-invasive mechanisms and for the development of treatments against SARS-CoV-2 based on green chemistry."