

# Specific immobilization of selected viral and bacterial pathogens on GaAs (001) surface

Valerie Duplan<sup>1</sup>, Yannick Miron<sup>2</sup>, Eric Frost<sup>3</sup>, Michel Grandbois<sup>2</sup>, Jan J. Dubowski<sup>1\*</sup>

<sup>1</sup>Department of Electrical and Computer Engineering, Faculty of Engineering, Sherbrooke University, Sherbrooke, Québec J1K2R1, Canada

<sup>2</sup>Department of Pharmacology, Faculty of Medicine, Sherbrooke University, Sherbrooke, Québec J1H5N4, Canada

<sup>3</sup>Department of Microbiology, Faculty of Medicine, Sherbrooke University, Sherbrooke, Québec J1H5N4, Canada

The conventional schemes for detection of viruses, bacteria, fungi and toxins include cell culture, immunological methods and molecular methods such as polymerase chain reaction [1]. These techniques, however, require much time and expertise in both sample preparation and data analysis. Development of alternative methods of detection that would be easy (automated), fast and specific for specific biomolecules would be advantageous for medical diagnostics, clinical analysis or field tests.

Optical and electronic properties of III-V and II-VI semiconductor quantum well (QW) and quantum dot (QD) microstructures are potentially attractive for building biosensing devices where miniscule perturbation of the semiconductor surface, induced by selectively trapped biomolecules, could be monitored rapidly and in-situ by measuring some of these properties. For instance, bright photoluminescence (PL) of colloidal CdSe QD has been investigated to develop fluorescent probes in sensing, imaging, immunoassay, and some other diagnostics applications.<sup>2</sup> We have proposed that templates of epitaxial QD, such as InAs QD in a GaAs matrix, offer significant advantage in designing a biosensor for rapid detection of numerous pathogens in parallel [3]. The proper functioning of such a photonic biosensor will depend on the ability to provide surface conditions suitable for specific attachment of targeted biomolecules. We have already demonstrated the successful immobilization of avidin on GaAs (001) surface [4].

In this report, we discuss the process allowing specific immobilization of influenza A virus and selected bacteria on the surface of GaAs (001) – a material of choice for capping some of the III-V

quantum semiconductors. The GaAs (001) surface was functionalized with biotinylated polyethylene-glycol (PEG) thiols. This served to attach neutravidin and antibodies for targeting specific biomolecules. The immobilization of Influenza A virus has been achieved using polyclonal antibodies against the Influenza A virus. The presence of viral nanoparticles on the GaAs surface was confirmed with atomic force microscopy (AFM) measurements carried out in a contact mode on samples immersed in liquid buffer (PBS) solutions. These results were also corroborated by fluorescence microscopy measurements on samples that were additionally exposed to fluorescein stained antibodies against Influenza A. An example of the fluorescence microscopy image obtained for such a sample is shown in Fig. 1. The additional evidence of specific immobilization has been provided by negative tests

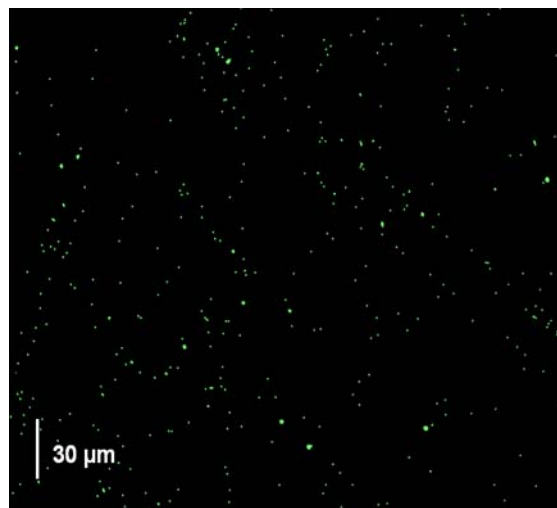


Fig. 1. Fluorescence microscopy image of a GaAs sample that following the specific immobilization of the Influenza A virus was exposed to fluorescein stained antibodies against the influenza A virus.

involving antibodies against Hepatitis B and Herpes (HSV1) stained with fluorescein that were carried out on such samples. Various strategies for immobilization of *Escherichia coli* and *Lactococcus lactis* have also been investigated. The results will be discussed in the context of the proposed GaAs-based photonic biosensor.

- [1] Y.X. Chen et al., J. Virol. Meth. **154**, 213 (2008).
- [2] H. Mattoussi et al., J. Am. Chem. Soc. **122** (49), 12142 (2000).
- [3] J.J. Dubowski, Lasers and Electro-Optics Society, LEOS 2006, 19th Annual Meeting IEEE: Montreal, 2006; Vol. 0-7803-9556-7, pp 302-3.
- [4] X. Ding et al., Appl. Phys. **A83**, 357 (2006).

\* E-mail: jan.j.dubowski@usherbrooke.ca