Virus interaction studies using MP-SPR

To develop cancer vaccines, a virus-peptide interaction was measured with Multi-Parametric Surface Plasmon Resonance (MP-SPR). Viruses were coated with peptides in order to increase virus immunogenicity. Oncolytic adenoviruses (OAds) were attached to the sensor surface. Tumor-specific major histocompatibility complex (MHC) peptides attachment to the OAds was measured in real-time. Modified positively charged polyK-SIINFEKL peptide bound to the virus surface (determined binding constant 2.88 x 10^{-6}M), whereas unmodified neutral SIINFEKL peptide did not bind.

Introduction

Besides vaccine research, viruses are extensively studied as drug delivery nanocarriers, and also their detection by nanobiosensors for diagnostic applications is in active research. In all of the research areas, real-time and label free methods are needed.

Multi-Parametric Surface Plasmon Resonance is a real-time label-free method that is used to measure molecular binding. Its unique optical setup allows measurements of small molecules causing small signal changes, but also large molecules including nanoparticles and viruses.

Materials and methods

Cleaned BioNavis silicon dioxide (SiO_2) sensor slides were coated *ex situ* with APTES ((3-aminopropyl)triethoxysilane) before immobilizing oncolytic adenoviruses *in situ* on the sensor surface (Figure 1). The measurement channel was coated with viruses, whereas a second channel was used as reference without viruses. 20 mM CHAPS was used to wash both channels before peptides PolyK-SIINFEKL or SIINFEKL were injected in parallel to both flow channels in series of increasing concentrations. Neutral SIINFEKL is tumor-specific major histocompatibility complex (MHC) peptide class I epitope derived from chicken ovalbumin and PolyK-SIINFEKL contains additional poly-lysine (polyK) chain which increases the net charge of the peptide to +6 mV at neutral pH.

Measurements were performed with a MP-SPR Navi™ 220A NAALI instrument in Angular Scan measurement mode, using 30 µL/min flow rate at 20°C.

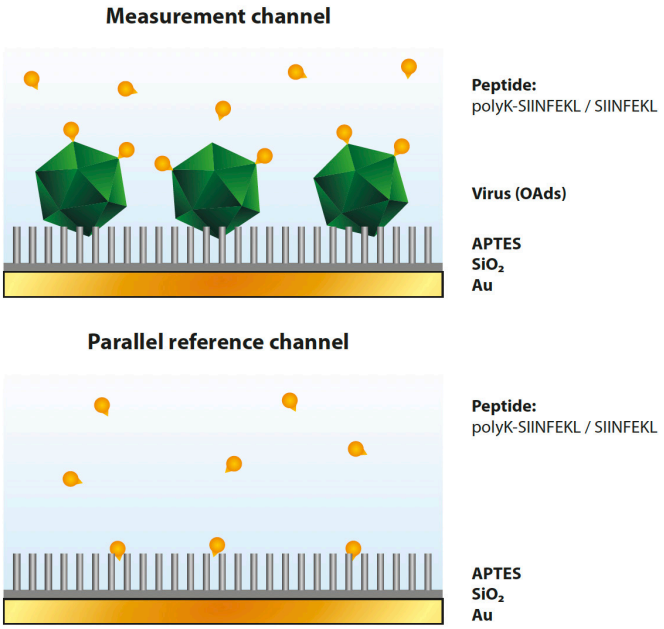

Figure 1. Peptides (SIINFEKL and polyK-SIINFEKL) interaction to viruses was measured. Viruses were attached on the SiO_2 sensor surface coated with APTES. Parallel to the measurement channel peptide interaction to the reference channel without viruses was measured.

Results and discussion

Modified positively charged PolyK-SIINFEKL showed concentration dependent adsorption onto the OAds whereas unmodified neutral SIINFEKL did not bind onto the viruses (Figure 2). The binding constant for PolyK-SIINFEKL interaction with OAds was determined to be 2.88 x 10^{-6} M.

In the future, peptides used for virus coating can be MHC-I epitopes or patient-derived tumor epitopes to exploit natural immunogenicity of adenoviruses and to develop personalized medicines for tumor specific immune response.

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email: info@bionavis.com
www.bionavis.com

Various experimental setups can be exploited for virus interaction measurements using MP-SPR. As seen in Figure 3A, viruses can be attached on the sensor surface (used as ligand) as described above or B, they can be moving freely in the liquid flow (used as analyte), while target is on the surface. Viruses and cells can be studied, where adherent cells are cultured on the MP-SPR sensor slides while viruses are injected as analytes. For instance, viruses were used as analytes when MP-SPR was utilized to develop biosensor for Maize chlorotic mottle virus (MCMV) detection (Zeng *et al.*,2013).

Conclusions

Interactions of viruses with molecules, cells or materials can be measured in real-time and without any labels using MP-SPR. The unique optical setup of MP-SPR provides valuable information about interaction kinetics and binding strength. MP-SPR exclusively encompasses the whole process from virus-target interactions, through virus-lipid all the way to virus-cell interactions and thus, paves the way to personalized medicine.

See how MP-SPR is utilized to measure lipid layers (AN#139) and small molecules interacting with protein (AN#144) or with living cells (AN#137).

Original publication:

Capasso *et al.*, OncoImmunology, 2015

Reference:

Zeng *et al.*, Analytical Biochemistry, 440, 2013
Feola *et al.*, Elife. 71156, 2022

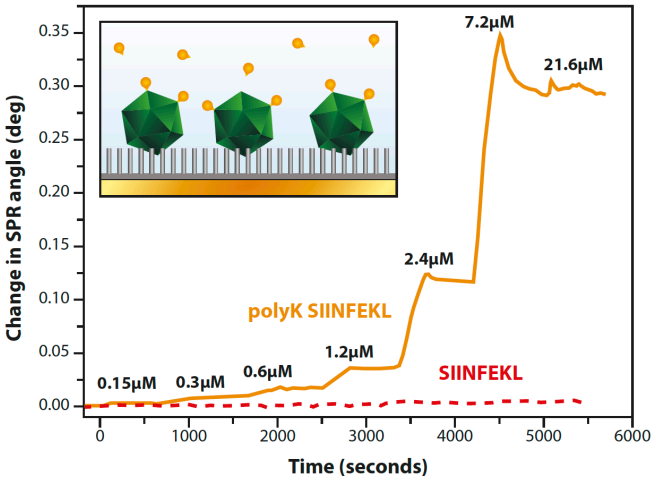

Figure 2. Peptides PolyK-SIINFEKL and SIINFEKL interaction with oncolytic adenoviruses (OAds).

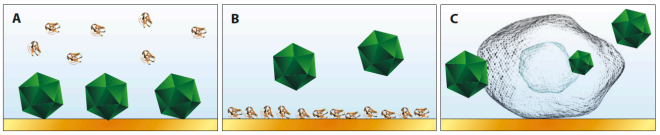

Figure 3. Virus studies using MP-SPR: A) virus on the surface, B) virus in the liquid flow C) virus entering the cell

Recommended instrumentation for reference assay experiments

MP-SPR Navi™ 420A ILVES or 220A NAALI

Sensor surface: SiO_2, or other inorganic coating

Software: MP-SPR Navi™ Controller, DataViewer, and TraceDrawer™ for MP-SPR Navi™

AN_145.c

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email: info@bionavis.com
www.bionavis.com