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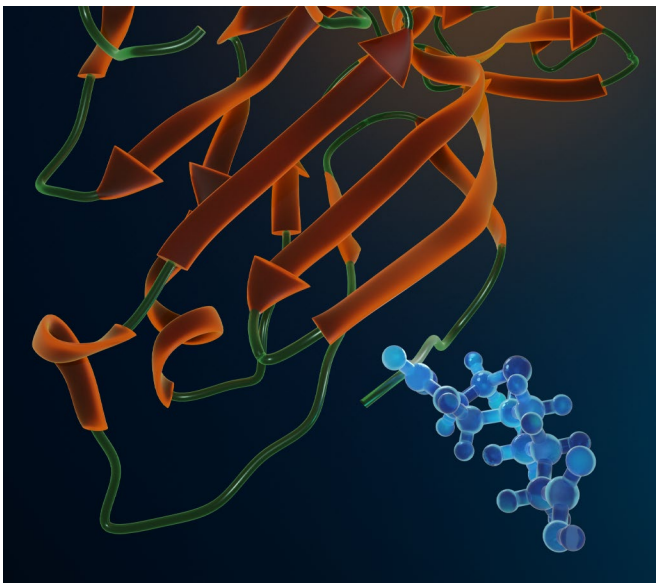
Application Note

Using Avi-tag Biotinylated Proteins to Determine Protein Interaction Kinetics and Affinity with Surface Plasmon Resonance

Introduction

Surface plasmon resonance (SPR) is a powerful, accurate, and direct way to measure protein interactions in real-time without the need for antibodies or detection reagents. Typically, a protein is covalently immobilized or non-covalently captured on a sensor chip, then an analyte is passed over the surface at varying concentrations and allowed to associate with the protein ligand. These binding events are detected by measuring changes in the refractive index caused by an increase of mass near the sensor chip surface. Biacore (GE Healthcare) is the most widely used SPR system and is currently used for all SPR experiments at R&D Systems. In a typical Biacore experiment, the covalently immobilized protein is often coupled to the sensor chip in a random orientation by amine or thiol coupling. This works well in many cases, however these random thiol or amine immobilization methods can produce unsatisfactory results, especially with small proteins or proteins with reactive groups in the binding interface resulting in valuable time spent troubleshooting. In this study, we employ R&D Systems Avi-tag Biotinylated Proteins along with streptavidin Series S chips to specifically and uniformly capture proteins in a Biacore experiment, as an alternative to chemical or amine coupling.



R&D Systems Avi-tag Biotinylated Proteins feature biotinylation at a single lysine residue that resides within the Avi-tag, a unique 15 amino acid peptide. The Avi-tag is enzymatically biotinylated by the *E. coli* biotin ligase BirA. All R&D Systems Avi-tag Biotinylated Proteins undergo rigorous QC testing to ensure high bioactivity and lot-to-lot consistency.

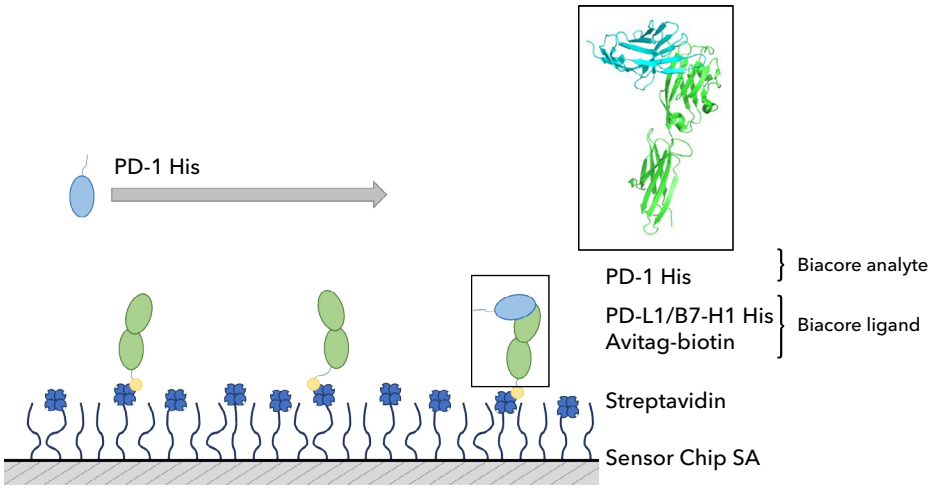
Materials And Methods

Binding measurements were performed by surface plasmon resonance (SPR) on a Biacore T200 instrument (GE Healthcare). R&D Systems Avi-tag biotinylated proteins, either Recombinant Human CD155/PVR Fc Chimera Avi-tag Protein (Catalog # AVI9174) or Recombinant Human PD-L1/B7-H1 His-tag Avi-tag Protein (Catalog # AVI9049) were captured at a low coupling density on Streptavidin Series S sensor chip SA (GE Healthcare), and increasing concentrations of the corresponding analytes, Recombinant Human TIGIT-Fc Protein (Catalog # 9464-TG) or Recombinant Human PD-1 His-tag Protein (Catalog # 8986-PD), respectively, were passed over both active and reference flow cells. Double-referenced sensorgrams were analyzed using the Biacore evaluation software to determine the binding kinetics and affinity.

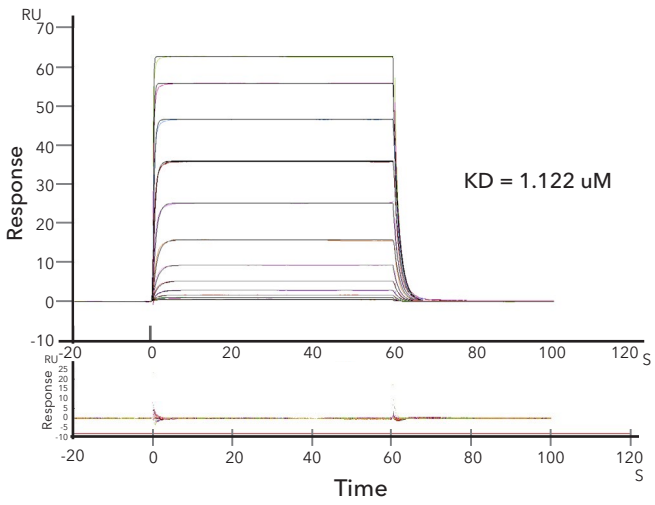
Results

We have chosen to highlight the use of our Avi-tag proteins in SPR experimentation by using the following Avi-tag products: Recombinant Human PD-L1/B7-H1 His-tag Avi-tag Protein (Cat# AVI9049) and Recombinant Human CD155/PVR Fc Chimera Avi-tag Protein (Cat# AVI9174). The binding interaction between the Recombinant Human PD-L1/B7-H1 His-tag Avi-tag Protein and Recombinant PD-1 His-tag is shown in Figure 1. We determined the interaction affinity using binding kinetics (B) as well as steady state affinity (C). In this experiment, recombinant human PD-L1/B7-H1 His-tag Avi-tag biotinylated protein was captured at a low coupling density to the active flow cell via the Avi-tag biotin. Then, recombinant PD-1 His-tag protein at a concentration range between 3.2 nM and 13.2 uM was passed over both active and uncoupled reference flow cells at each concentration. The association phase at each concentration was 60 seconds followed by a 40 second dissociation. Double-referenced sensorgrams of captured Recombinant Human PD-L1/B7-H1 His-tag Avi-tag Protein binding to Recombinant PD-1 His-tag and the corresponding overlaid kinetic fits are shown in Figure 1B. Kinetic sensorgrams were fit to a 1:1 binding model and the interaction affinity was calculated at KD = 1.122 µM. The steady state affinity calculation is in line with the kinetic data producing an affinity of KD = 1.528 uM Figure 1C.

A. PD-1:PD-L1 Schematic



B. PD-1:PD-L1 Sensorgrams



C. PD-1:PD-L1 Steady State Affinity Fit

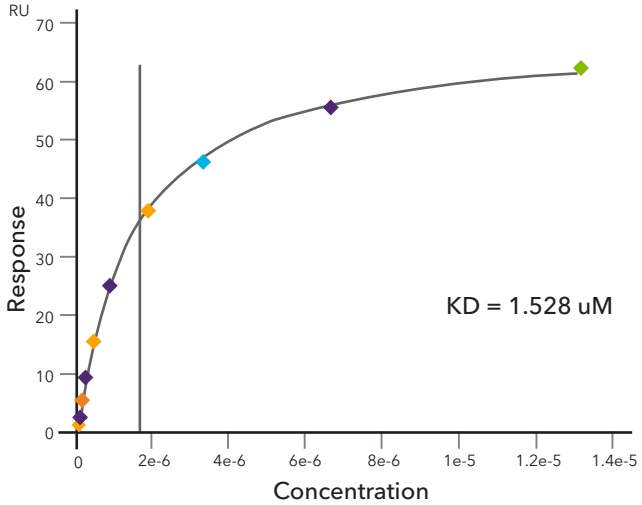
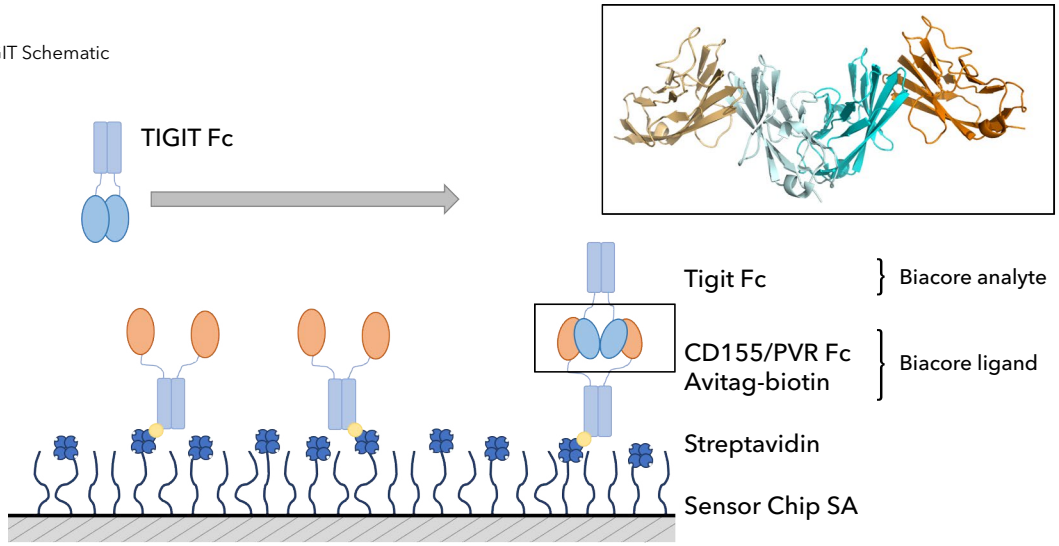


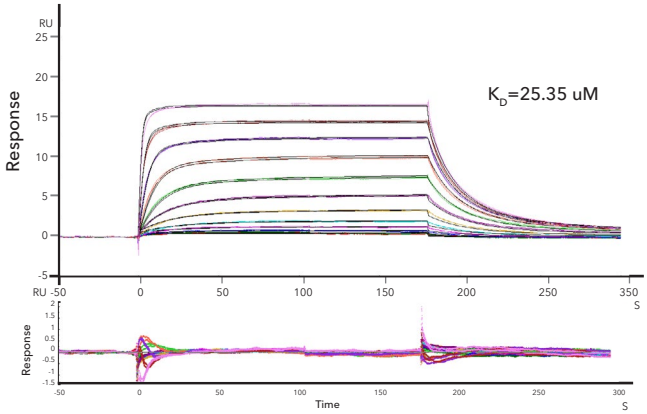
Figure 1. Affinity measurements and binding kinetics of the PD-1:PD-L1 interaction by SPR. (A) Schematic cartoon of the SPR experiment. Ribbon structure from www.rcsb.org/structure/3BIK. (B) The corresponding overlaid kinetic fits with the residual plot below showing sensorgram data of captured Recombinant Human PD-L1/B7-H1 His-tag Avi-tag binding to Recombinant Human PD-1 His-tag. The concentration of PD-1 His-tag ranged from 3.2 nM to 13.2 uM. (C) The corresponding steady state affinity fit.

Next, we analyzed the CD155/PVR:TIGIT binding interaction using this same method. The results of this SPR experiment also performed on the Biacore T200 are shown in Figure 2. Here, we captured recombinant human CD155/PVR Fc Chimera Avi-tag at a low coupling density to the active flow cell via the biotin moiety residing within the Avi-tag. Recombinant human TIGIT-Fc was passed over both active and uncoupled reference flow cells in duplicate at different concentrations ranging from 0.2 nM to 400 nM. The association phase at each concentration was 180 seconds followed by a 120 second dissociation. Double-referenced sensorgrams were fit to a 1:1 binding model to determine the binding kinetics and affinity, and the calculated interaction affinity was KD = 25.35 nM Figure 2B. Steady state affinity is plotted in Figure 2C and the determined affinity of KD = 36.14 nM falls in line with the kinetic data. These affinity results are consistent with the TIGIT Fc chimera protein interacting with CD155/PVR Fc chimera (non-biotinylated) covalently immobilized using amine chemistry (data not shown).

A. CD155/PVR:TIGIT Schematic



B. CD155/PVR:TIGIT Sensorgram



C. CD155/PVR:TIGIT Steady State Affinity Fit

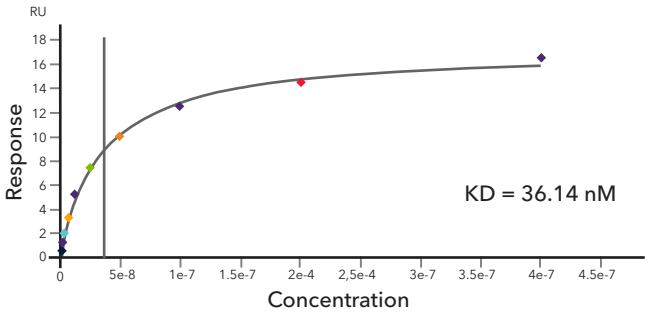


Figure 2. Affinity measurements and binding kinetics of the CD155/PVR:TIGIT interaction by SPR. (A) Schematic cartoon of the SPR experiment. Ribbon structure from rcsb.org/structure/3UDW. (B) Sensorgram data of captured Recombinant Human CD155/PVR Fc Avi-tag binding to Recombinant Human TIGIT His-tag and the corresponding overlaid kinetic fits with the residual plot shown below. The concentration of TIGIT His-tag ranged from 0.2 nM to 400 nM. (C) The corresponding steady state affinity fit.

Conclusions

In this study we demonstrate how R&D Systems Avi-tag Biotinylated Proteins can be used in conjunction with Streptavidin Series S Sensor Chips to generate useful kinetic and affinity measurements by surface plasmon resonance using Biacore.

Ordering Information

Select Avi-tag proteins are listed below. For an up-to-date product list visit the Avi-tag proteins page on bio-techne.com

5T4	B7-1/CD80	B7-2/CD86	B7-H2	B7-H3	B7-H4	B7-H6
BCMA/TNFRSF17	BTN1A1/ Butyrophilin	BTN2A1	BTN3A2	CD19	CD25/IL-2 R	CD30/TNFRSF8
CD40/TNFRSF5	CD47	CD155/PVR	CTLA-4	DNAM-1/CD226	EGF R	EpCAM/TROP1
ErbB2/Her2	ErbB3/Her3	Fc gamma RIIB/ CD32b	Fc gamma RIIA/ CD32a	Fc gamma RIIIA/ CD16a	GITR/TNFRSF18	ICAM-1/CD54
IFN gamma R1/ CD119	IgG1	IL-7 R alpha/CD127	IL-12 R beta 1	LAG-3	LAIR1	LAIR2
LILRB2/CD85d/ ILT4	Lymphotoxin alpha 1/beta2	M-CSF R/CD115	Mesothelin	MICA	MSP R/Ron	Nectin-2/CD112
NKp30	NKp44/NCR2	OX40/TNFRSF4	PD-1	PD-L1/B7-H1	PD-L2/B7-DC	PDGF R alpha
PDGF R beta	PSMA/FOLH1/ NAALADase I	Siglec-2/CD22	Siglec-3/CD33	Siglec-10	SIRP alpha/ CD172a	TIGIT
TIM-1/KIM-1/ HAVCR	TIM-3	TNF-alpha	TNF RI/TNFRSF1A	TNF RII/ TNFRSF1B	uPAR	VEGF165
VEGF R2/KDR/ Flk-1	VEGF R3/Flt-4	VISTA/B7-H5/ PD-1H	VSIG3	VSIG4	VSTM2A	VSTM2B

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