
Detection of Mouse MCP-1 with AlGaN/GaN HEMTs

Nayeli Espinosa

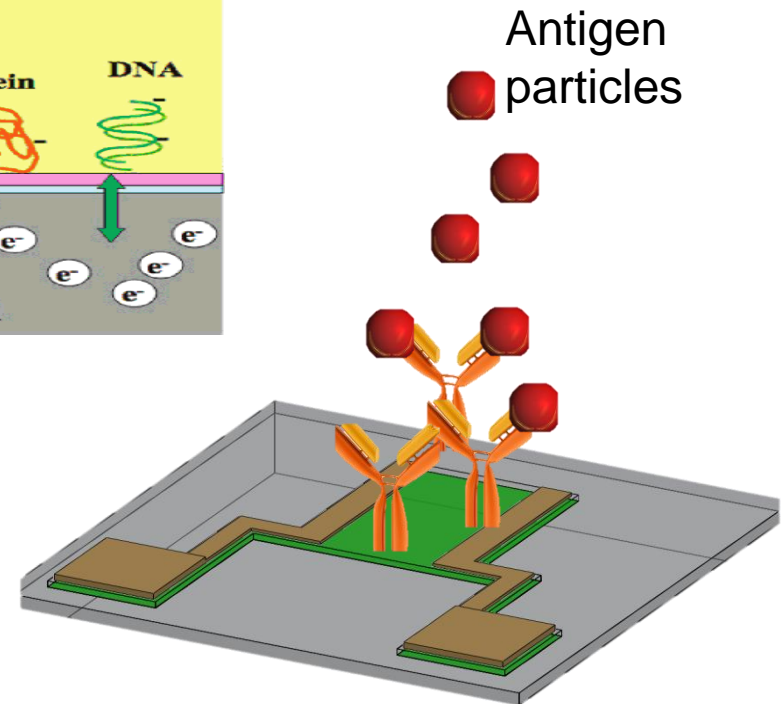
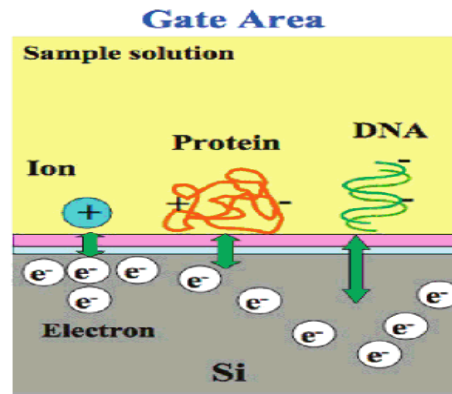


Overview

- Introduction
 - Why AlGaN/GaN?
 - Principles of biosensing
- Gate functionalization -> MCP-1 detection
- Protein Detection Setup
- Results
 - Transfer Characteristics Curve
 - Dynamical response -> Time Constant
- Conclusions

Introduction

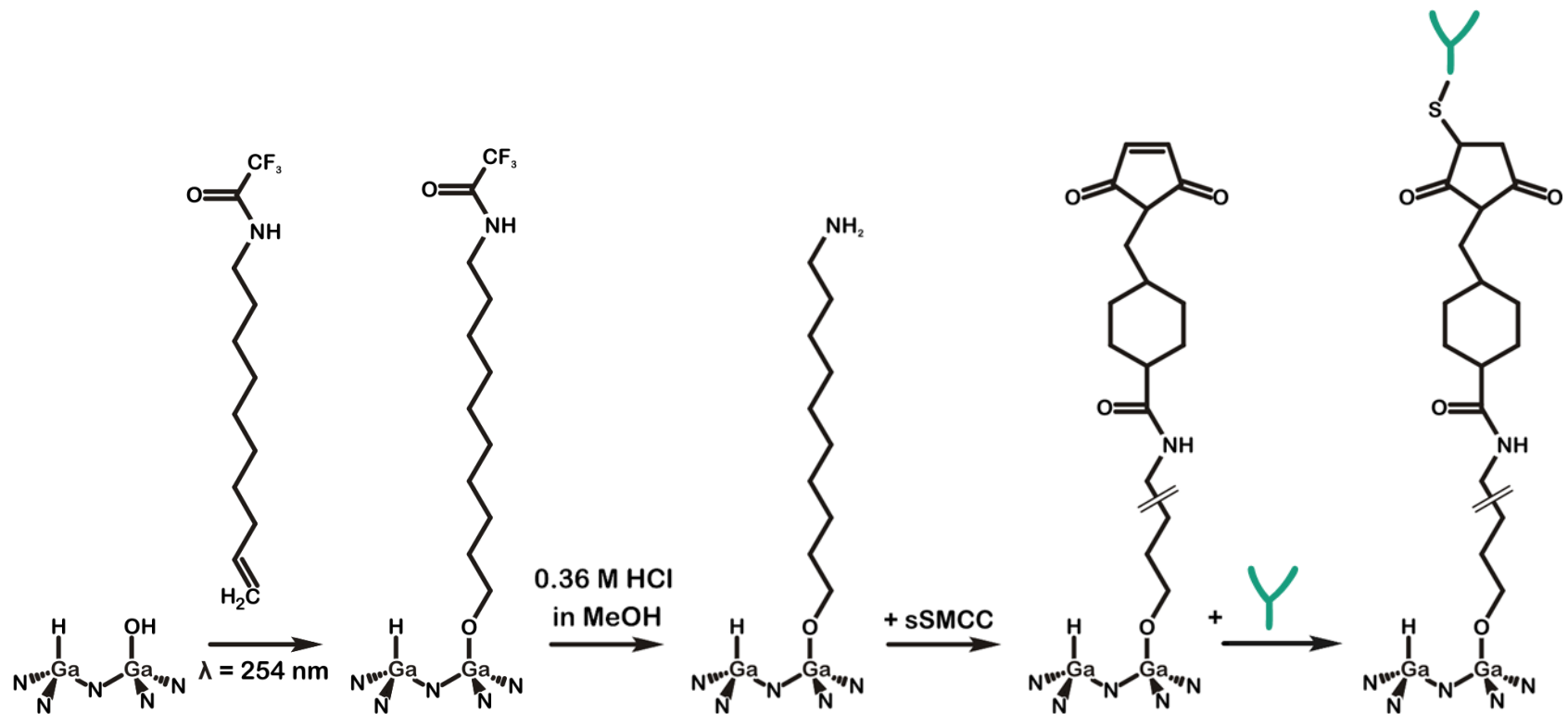
- AlGaIn/GaN HEMTs
 - Biocompatible → chemically stable
 - High sensitivity
 - Biosensing
- AlGaIn/GaN ImmunoFET
 - Antibody immobilization
 - Electrical antigen detection
- Applications
 - Medical Diagnosis
 - Food industry



Gate functionalized with
Antibody

Gate functionalization

■ Covalent antibody immobilization via cysteine thiol groups



Protein detection setup

■ Functionalized Transistors

- Antibody → Anti-MCP-1

- (Mouse Specific)

- Target protein (100 ng/ml) → Mouse and Human MCP-1

■ Gate area (μm^2)

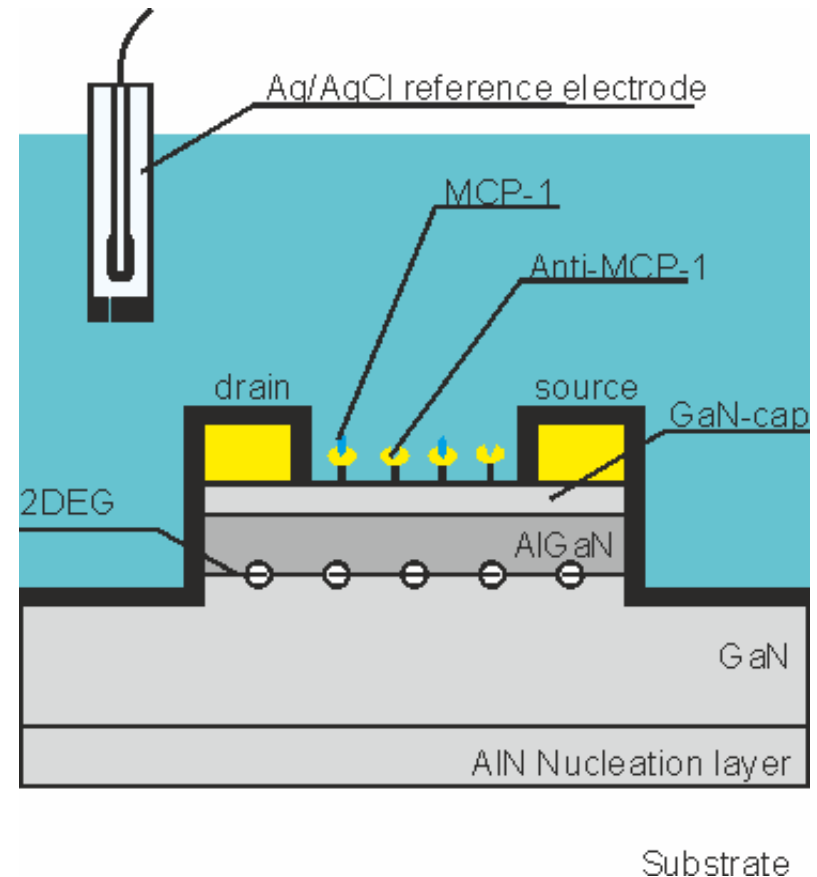
- 400 x 50 (L x W)

■ PBS pH=7.0

■ Reference Electrode

- -2 V to 2 V

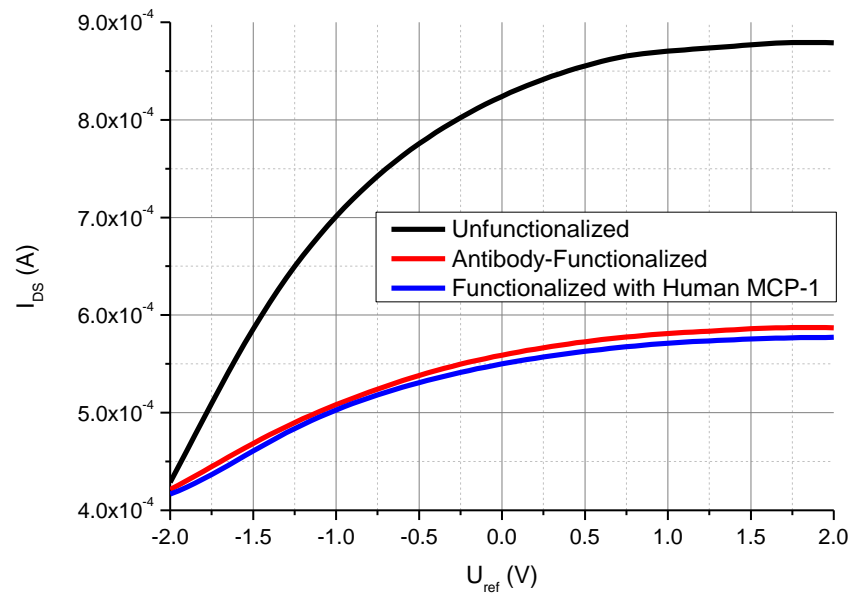
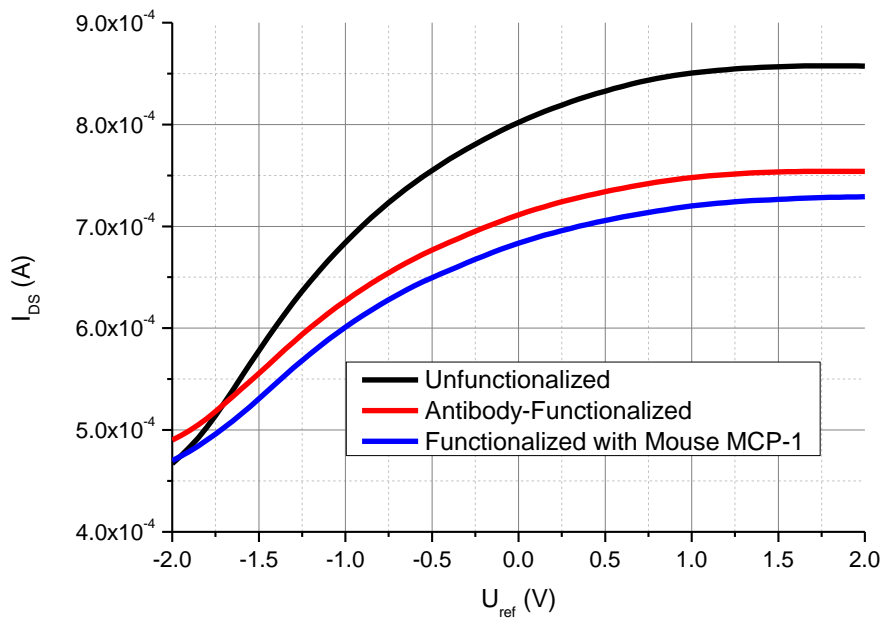
- --+200 mV



Results

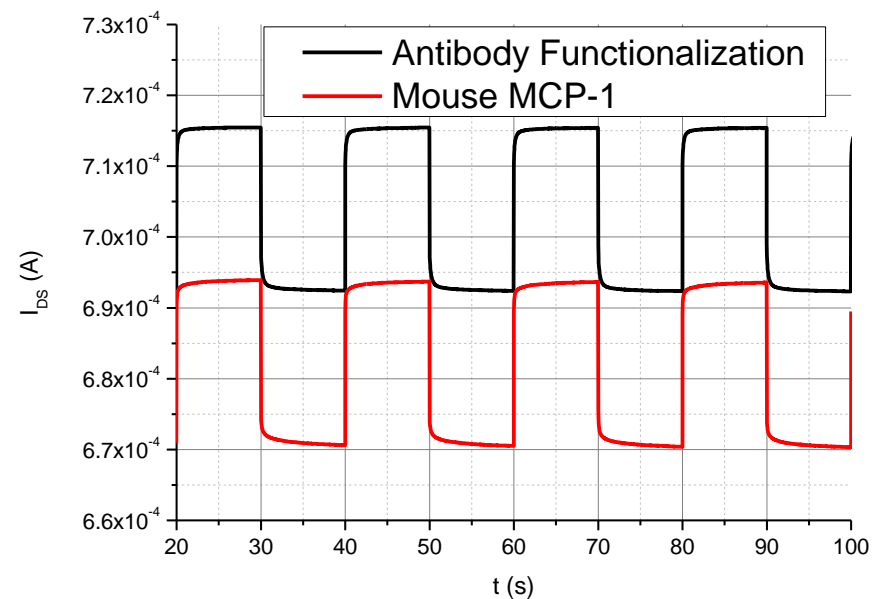
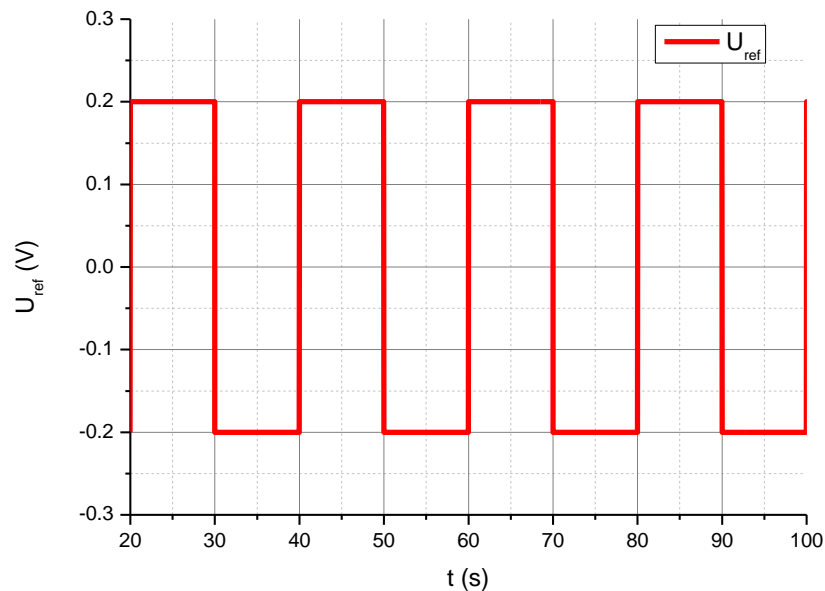
■ Transfer Characteristics Curve

- Lower I_{DS} -> Gate functionalization
- Higher ΔI_{DS} -> Mouse MCP-1
- Lower ΔI_{DS} -> Human MCP-1 (Control Experiment)



Results

- Transistor dynamical response -> first order system
 - Input -> $U_{ref} = \pm 200 \text{ mV}$
 - Output -> I_{DS} -> time constant -> how fast follows the Input

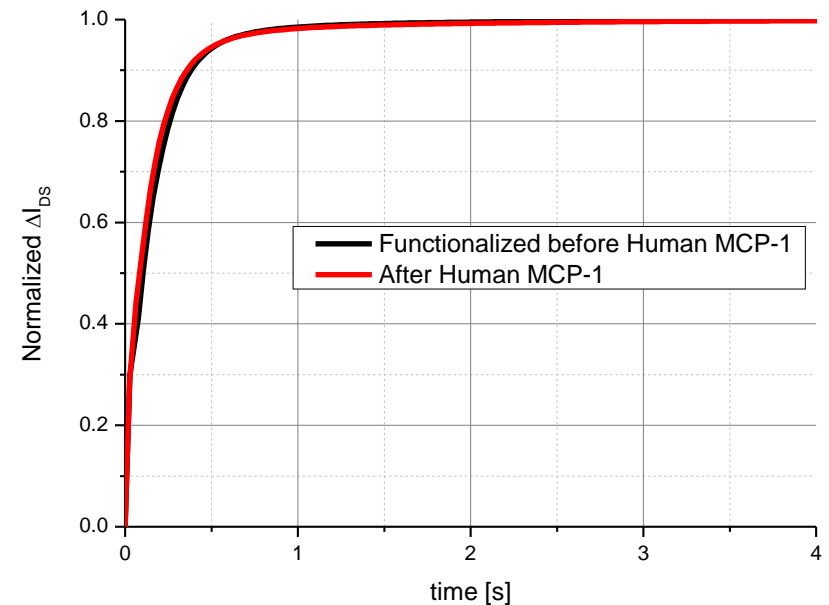
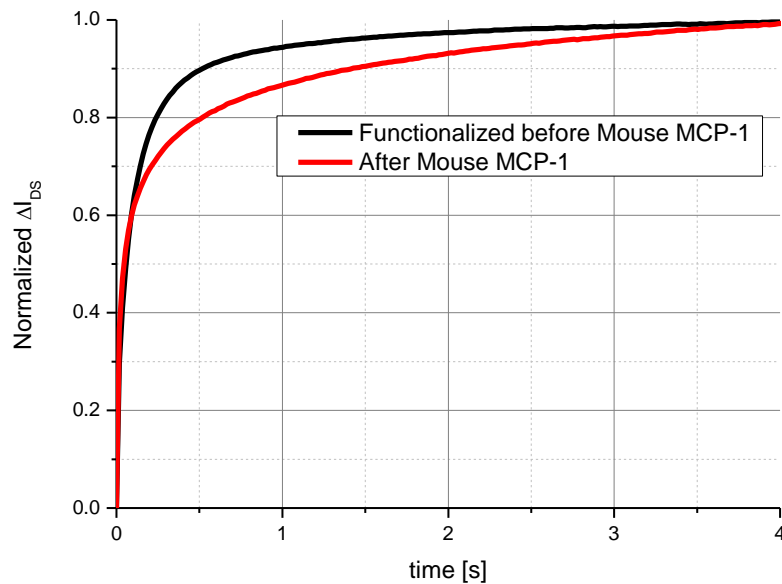


Results

■ Dynamical response

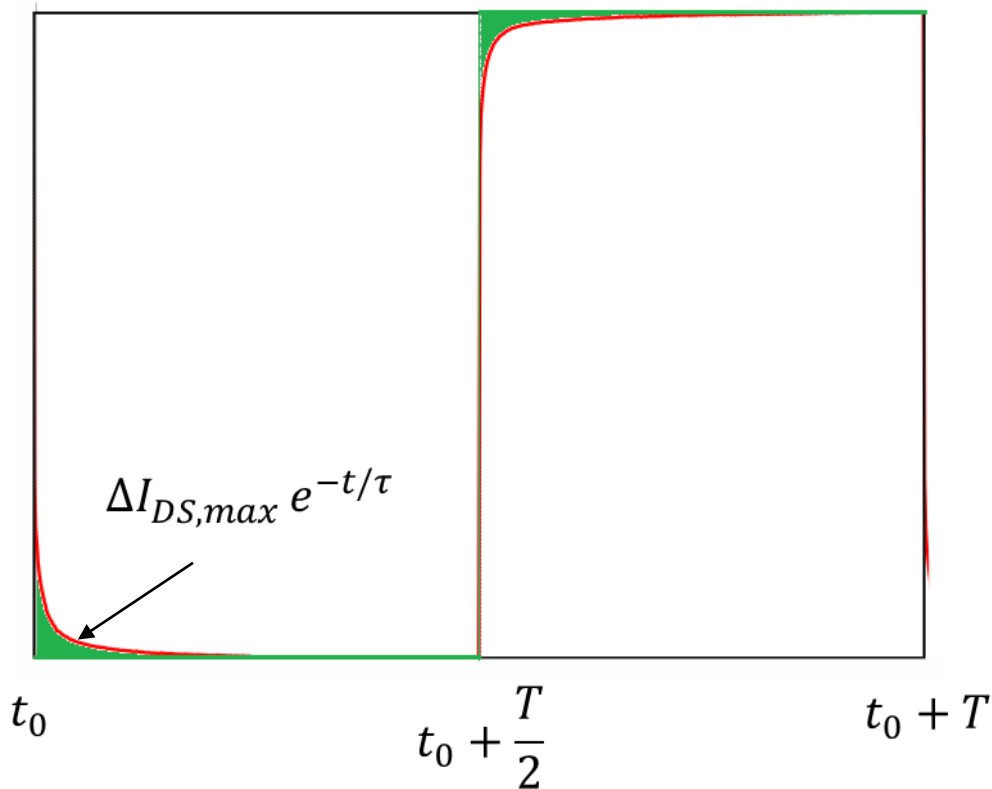
■ Slower -> After Mouse MCP-1

■ Similar -> After Human MCP-1



Results

■ Time constant calculation (τ)



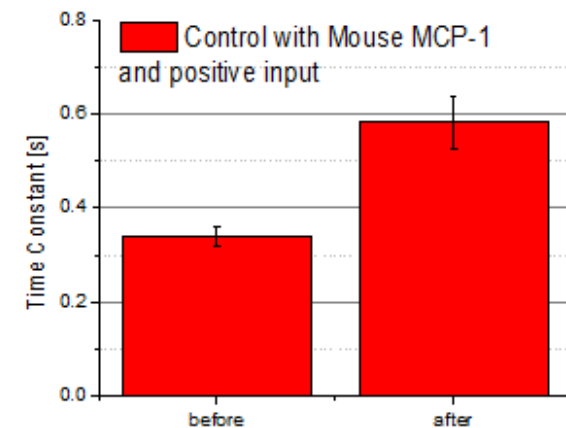
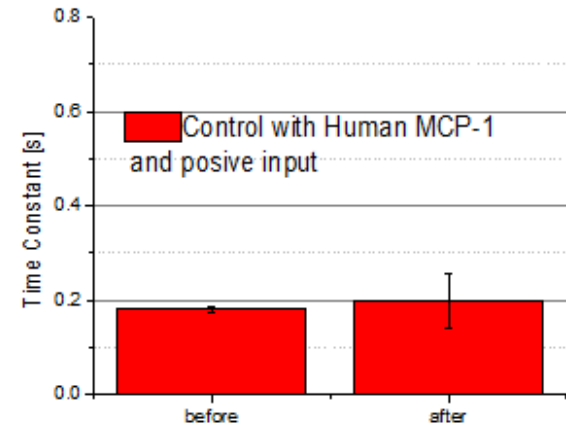
$$\tau = \int_0^{\infty} e^{-t/\tau} dt$$

$$\tau \approx \int_{t_0}^{t_0 + \frac{T}{2}} \Delta I_{DS,max} e^{-t/\tau} dt$$

$\tau \approx$ *Area under the curve*

Results

- Average time constant for positive pulses
- Higher -> Mouse MCP-1 -> 0.34 to 0.58 s
- Similar -> Human MCP-1 (Control Experiment) -> 0.18 to 0.19 s

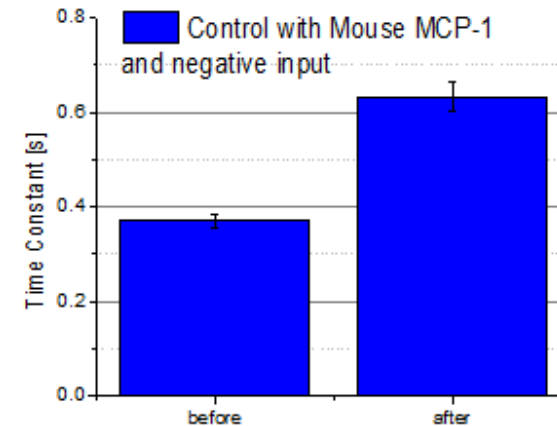
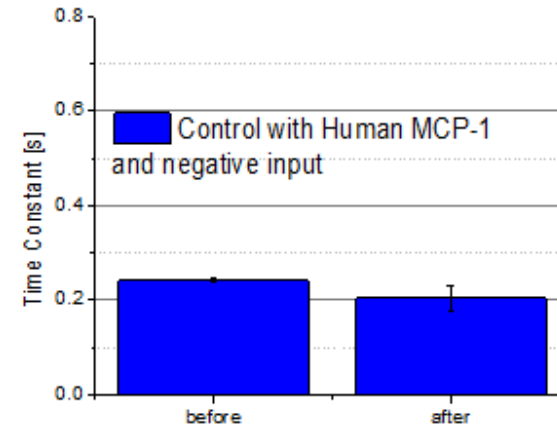


Results

■ Average time constant for negative pulses

■ Higher -> Mouse MCP-1 -> 0.37 to 0.63 s

■ Similar -> Human MCP-1 (Control Experiment) -> 0.21 to 0.2 s



Conclusions

- Detection of target proteins -> successful with AlGaN/GaN HEMTs
- Novel dynamic measurement scheme -> average time constant