

Evaluation of Alzheimer’s Disease (AD) Biomarkers by SERS-Based Immunoassay in SH-SY5Y Cell-line Mode

aaic2026.20703a7

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Surface-Enhanced Raman Spectroscopy (SERS) accurately reflects APP- and Tau-associated biomarker changes in cellular Alzheimer's disease models, demonstrating strong agreement with ELISA and supporting its potential as a rapid and sensitive platform for Alzheimer's biomarker detection having the capacity for clinical translation

INTRODUCTION

- Alzheimer's disease is characterized by the accumulation of amyloid- β and tau, which precede clinical symptoms.
- Early and accurate biomarker detection is crucial for improving diagnosis and treatment outcomes.
- APP- and tau-overexpressing cell models were used to evaluate biomarker expression using ELISA, WB, and SERS. The analytical performance of SERS was compared with ELISA for biomarker quantification.

METHODS

- Biomarkers were quantified using ELISA, WB and SERS.
- SERS immunoassay nanoprobe: Capture probe: FeNP@Au@PEG@mAb made by co-precipitation method.
- Detection probe: AuNP@RR@PEG@pAb made by Turkevich method.

WORK FLOW

1 Transient transfection in SH-SY5Y cellline

SH-SY5Y cells

Control

APP Overexpression

Tau Overexpression

2 Sample Collection

Cell lysate & Conditioned media

3 ELISA Analysis

Detection Antibody

Target Biomarker

Capture Antibody

Biomarkers quantified using commercial ELISA kits.

Concentrations calculated from standard curves.

4 SERS Analysis

Laser

Intensity

Characteristic Raman Reporter peak

Raman Shift (cm⁻¹)

Samples were incubated with SERS nanoprobe: FeNP@Au@PEG@mAb (Capture probe) and AuNP@RR@PEG@pAb (detection probe).

SYNTHESIS OF NANOPARTICLES

FeNP

FeNP@Au

FeNP@Au@PEG

FeNP@Au@PEG@mAb

Iron nanoparticle

+ Gold

+ FeNP@Au@PEG

+ FeNP@Au@PEG@mAb

+

+

+

+

+

+

+

+

+

+

+

+

+

+

+

+

AuNP

AuNP@RR

AuNP@RR@PEG

AuNP@RR@PEG@pAb

Gold nanoparticle

+ Raman Reporter (4-Nitrothiophenol)

+ AuNP@RR@PEG

+ AuNP@RR@PEG@pAb

+

+

+

+

+

+

+

+

+

+

+

+

+

+

+

+

CHARACTERIZATION OF NANOPARTICLES

UV-Visible Spectroscopy

TEM

FeNP

AuNP

Absorbance (a.u.)

Wavelength (nm)

FeNP

AuNP

0.00

0.25

0.50

0.75

1.00

400

500

600

700

800

FeNP@Au

AuNP

0.00

0.25

0.50

0.75

1.00

400

500

600

700

800

FeNP@Au

AuNP

0.00

0.25

0.50

0.75

1.00

400

500

600

700

800

APP

Tau

A β 40

A β 42

1.26

1.38

1.16

2.22

2.9

3.24

3.31

2.75

24 Hour

48 Hour

FOLD CHANGE

APP in Cell Lysate

Raman Reporter: ATP

Characteristic peak: 1575cm⁻¹

A β 40 in Conditioned Media

Raman Reporter: SDL

Characteristic peak: 580cm⁻¹

Tau in Cell Lysate

Raman Reporter: NTP

Characteristic peak: 1330cm⁻¹

A β 42 in Conditioned Media

Raman Reporter: NTP

Characteristic peak: 580cm⁻¹

Control

Transfected

Control

Transfected

Control

Transfected

Control

Transfected

APP

Tau

A β 42

A β 40

5

0

COMPARITIVE ANALYSIS OF FOLD CHANGE

A β 42 (oligomer)

Tau

β -Actin

Control(C)

Transfected(T)

>25 kDa

62 kDa

42 kDa

CONCLUSIONS

- ELISA and Western blot confirmed successful overexpression of AD biomarkers in APP- and tau-overexpressing SH-SY5Y cells.
- SERS showed strong agreement with ELISA in detecting A β and tau biomarkers.
- These findings support SERS as a rapid, sensitive, and reliable platform for Alzheimer's disease biomarker detection with potential for early diagnosis.

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