

Industry Day Theme # {Healthcare/SMT}

Surface enhanced Raman Spectroscopy (SERS) based Biosensors in medical diagnostics

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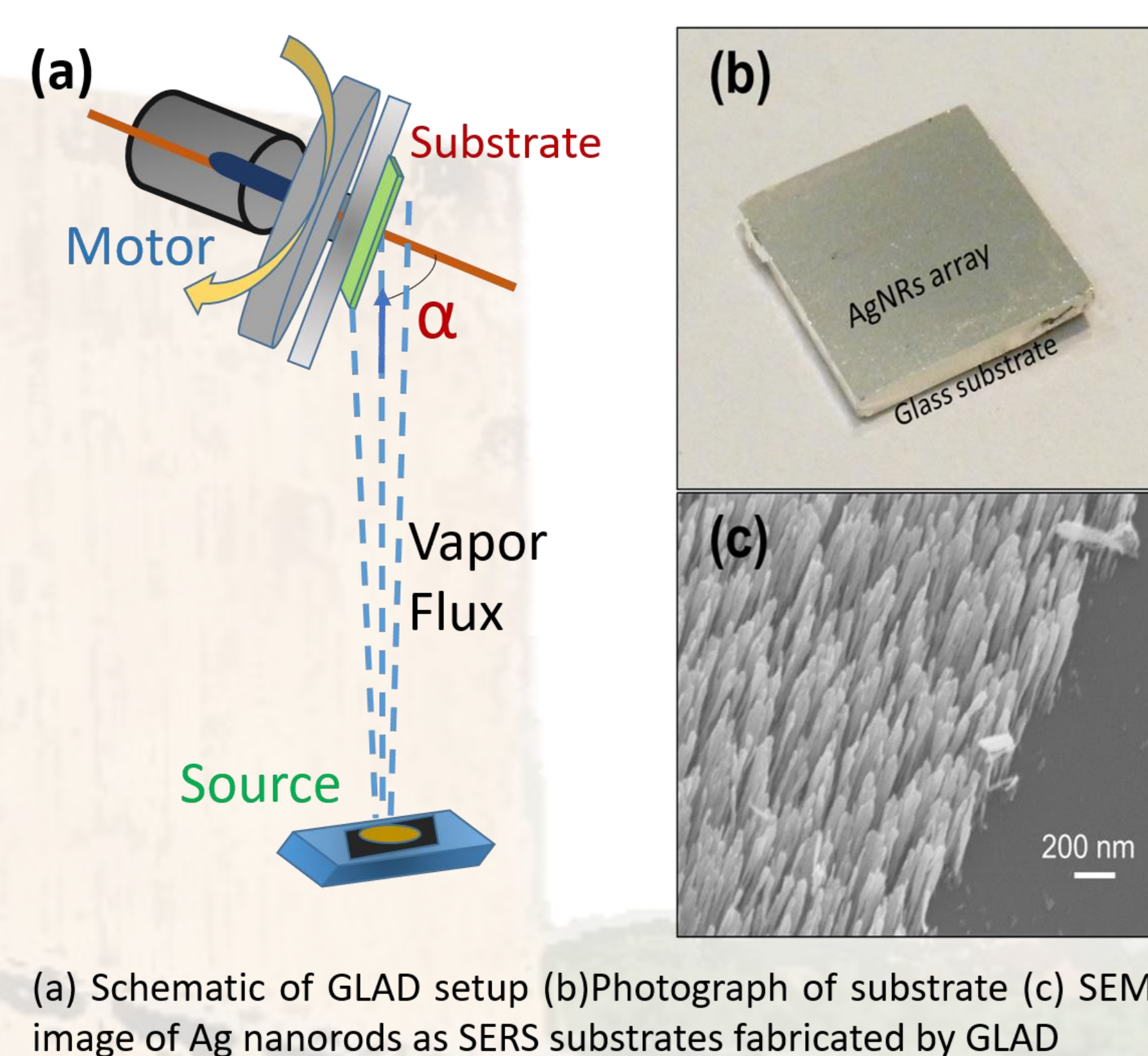
Abstract

SERS has been emerged as a potential tool for chemical and biosensing. It is referred to be the fingerprint of molecule associated to the analyte. Morphology and dimensions of SERS substrates have vital role in order to enhance the Raman signal. We fabricate the various nanosculptured thin films in order to achieve a high value of enhancement for detection of biological species.

Introduction

Rapid, specific and on-site diagnosis of viral diseases at the early stage is challenging. Currently used techniques e.g. ELISA and RT-PCR have some limitations as sensitivity, time consuming, complicated and expensive procedures; hence can not be applied for large scale rapid screening. Similarly in bacterial infection conventional techniques takes time in which it may become life threatening. Thus, there is urgent need for developing a rapid and reliable bio-analytical method that employs current tools of nanotechnology for direct diagnosis of viral/bacterial infections. Recently, SERS have been utilized for detection because of its ability to provide detailed information regarding the chemical composition of the microorganisms.

Materials and Methods



- **Glancing angle deposition (GLAD)** is physical vapor deposition technique to fabricate a various kind of nanostructured substrates.
- Substrate placed at tilt angle leads to deposition angle leads to grow nanocolumnar structures.
- Shadowing effect and surface diffusion play major role to form rods like structures.
- Substrates rotations lead into the formation of various substrates.
- Silver nanorods (AgNRs) fabricated by GLAD, packaged in inert gas have been employed as efficient SERS substrates for sensing application.

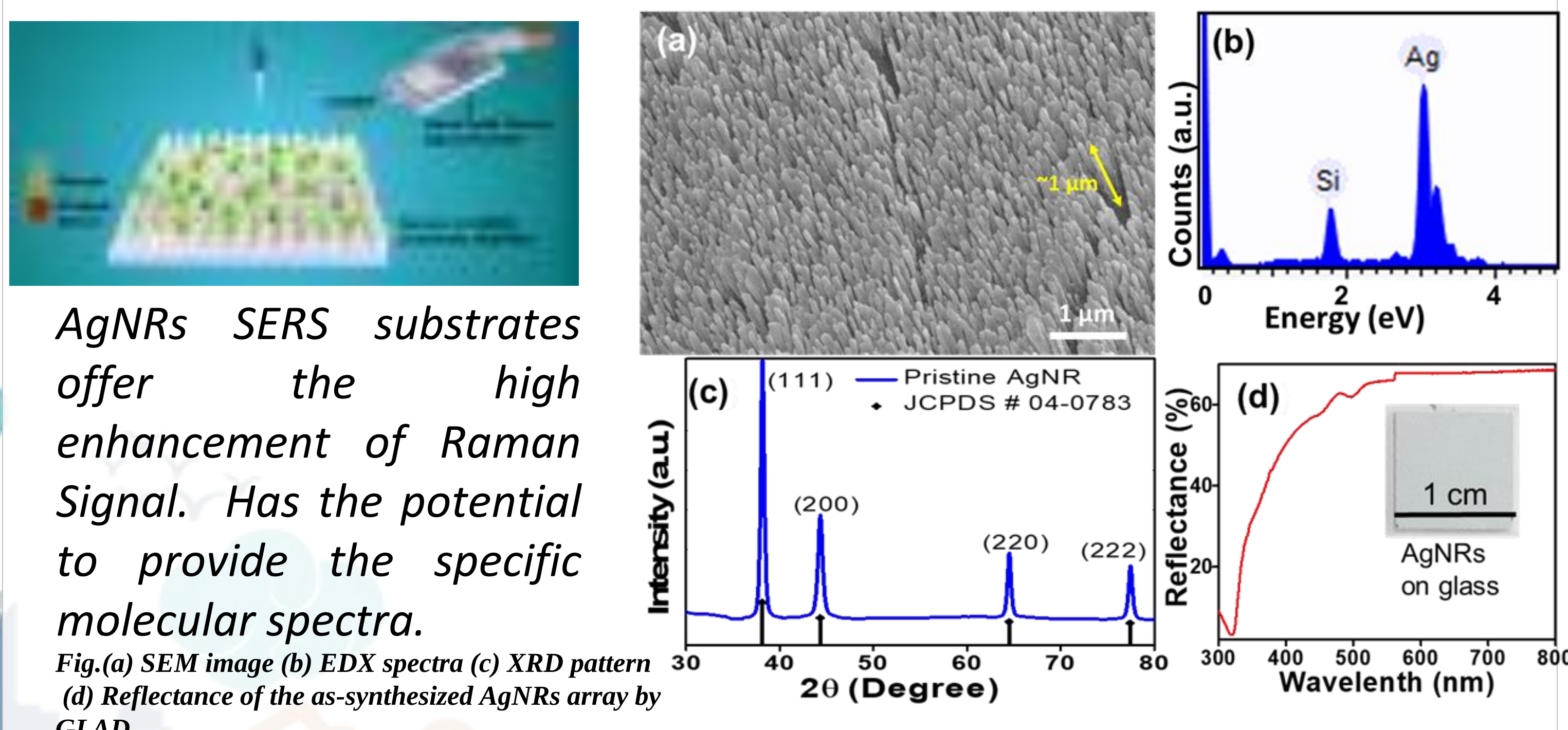
Conclusion: We have demonstrated SERS based diagnosis of Dengue using silver nanorods array fabricated by GLAD. SERS substrates were optimized to high sensitivity with high enhancement factor. Enhancement factor of 10^7 has been obtained on Raman probe (BPE) using as-fabricated SERS substrates. Repeatability of Raman spectra has been achieved and statistically approved. Blood serum samples from different subjects (100) were collected from fever clinic of National Institute of Malaria Research (NIMR) New Delhi. We have analyzed all the data and differentiated the NS1 positive, NS1 negative and healthy samples using a mathematical tool PCA employing PC1 and PC2 components. In the Dengue positive samples, NS1 characteristic peak is visible. All the Raman bands were assigned to the respective constituents of blood serum. This rapid, portable, cost effective and user friendly technique renders early detection of Dengue with high

Industrial Significance

To design and develop indigenous hand held device, industry's contribution is highly essential in terms of hardware as well as software part.

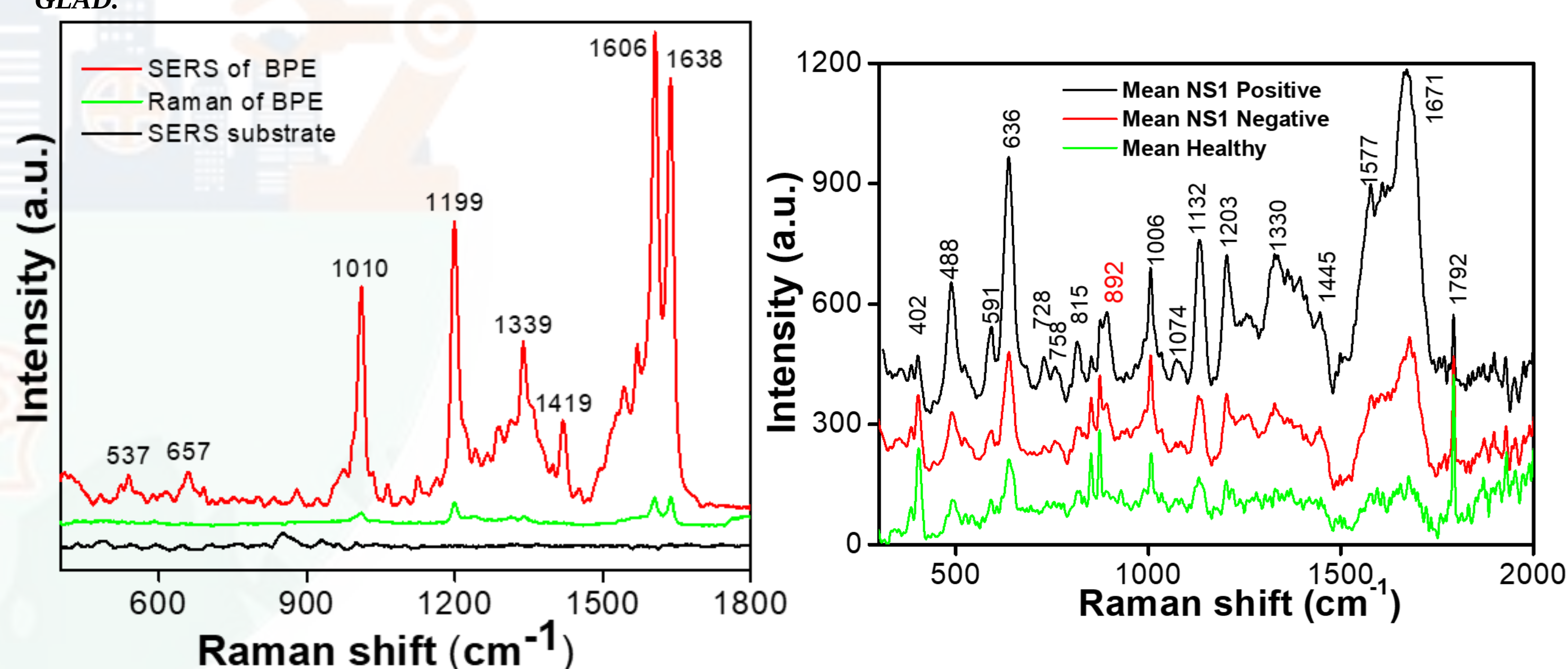
Technology Readiness Level: The hand held SERS device for diagnosis of vector generated diseases may be the next diagnostic tool in hospitals and clinics.

Results and discussion

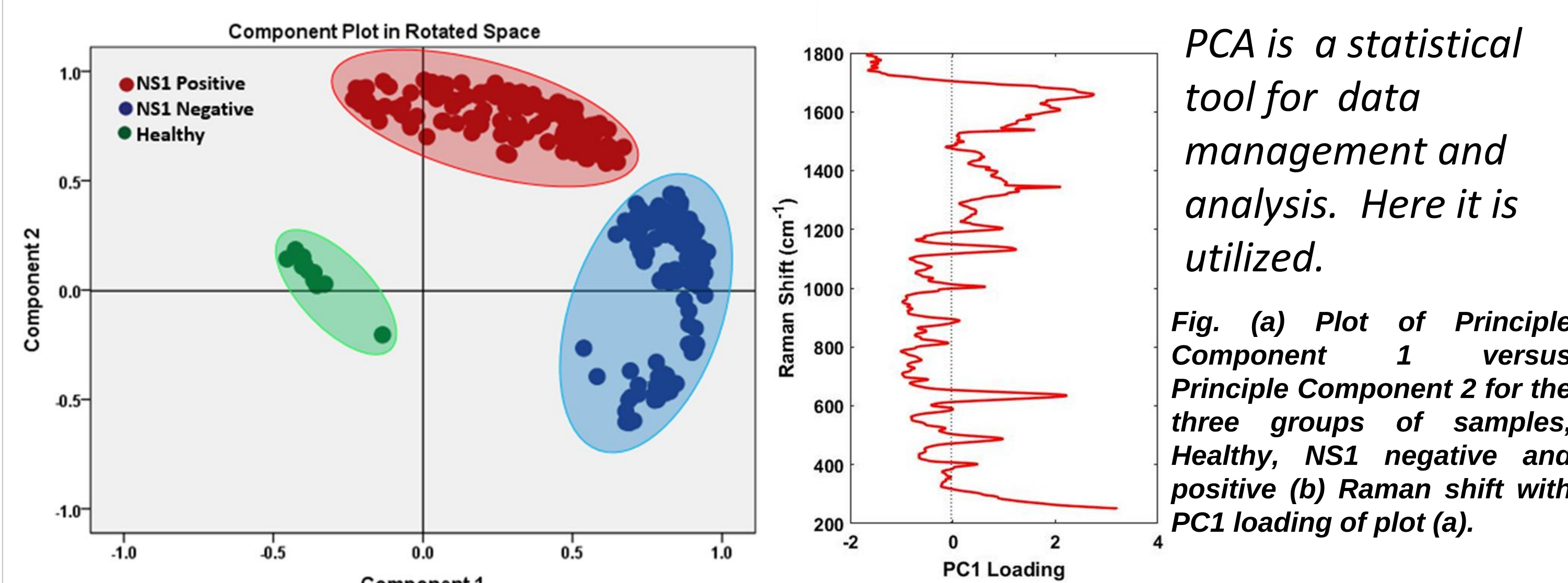


AgNRs SERS substrates offer the high enhancement of Raman signal. Has the potential to provide the specific molecular spectra.

Fig.(a) SEM image (b) EDX spectra (c) XRD pattern (d) Reflectance of the as-synthesized AgNRs array by GLAD.



The comparison of Raman and SERS spectra of BPE molecule. The $1 \mu\text{M}$ BPE drop-casted on AgNRs (SERS) red, 10 mM BPE deposited repeatedly 10 times on the bare glass (Raman) green, the bare AgNRs (control) black. The calculated enhancement factor obtained was 1×10^7 .



PCA is a statistical tool for data management and analysis. Here it is utilized.

Fig. (a) Plot of Principle Component 1 versus Principle Component 2 for the three groups of samples, Healthy, NS1 negative and positive (b) Raman shift with PC1 loading of plot (a).



Ongoing work:

- The in-house developed portable Raman spectrometer set up shown in photograph is under trials with real samples.
- A data base is being generated to form a library.
- Statistical tool Principal component analysis (PCA) is to be incorporated in the system for data analysis and discrimination.

References

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Acknowledgement

