Crystal engineering to fabricate twin boundary induced highly strained network of Au doped Ag nanorod with excellent catalytic efficiency: Bridging application from catalysis to sensing for early detection of dengue serotype-2 and its related metabolites in human serum

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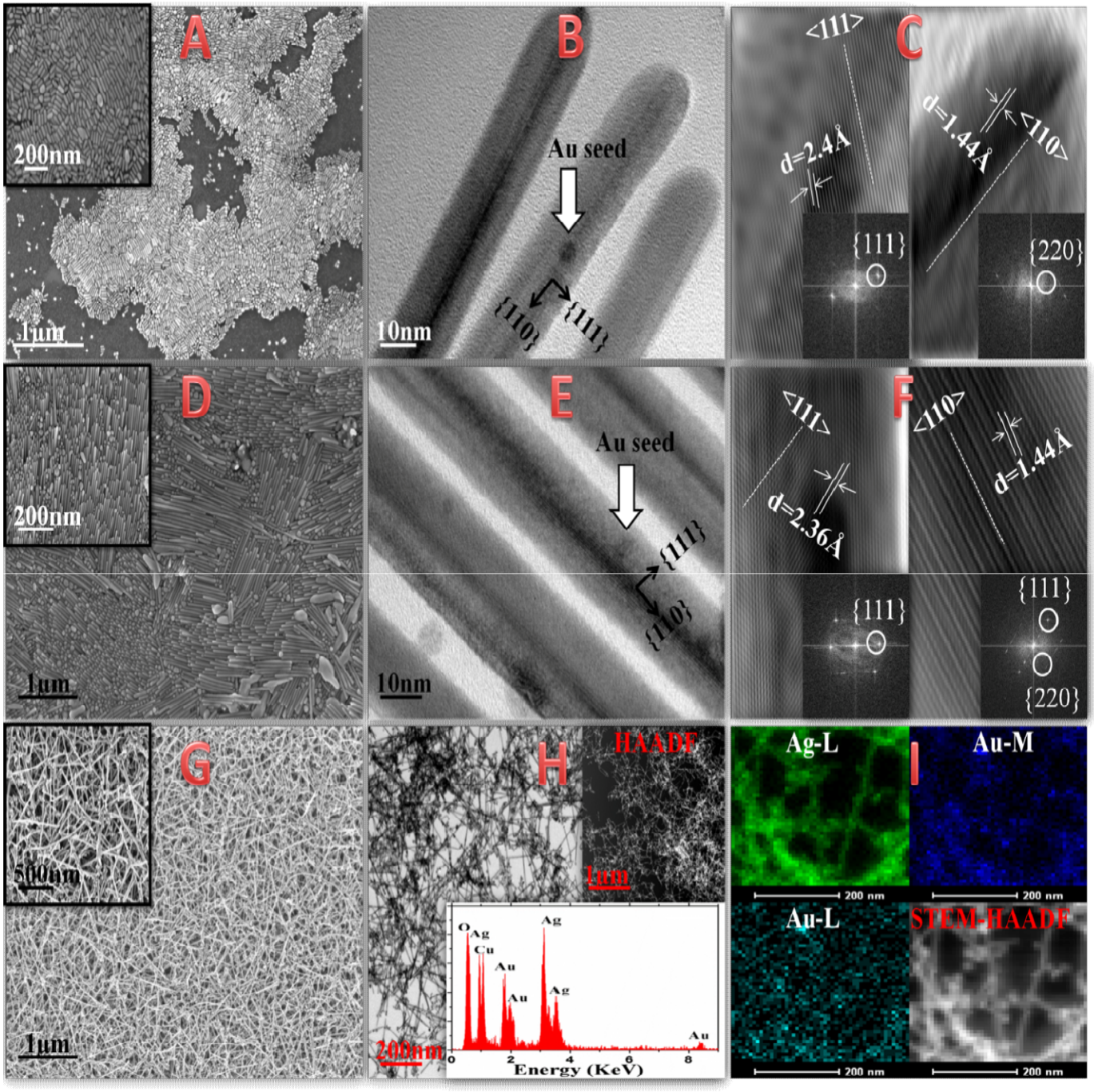
Different sized Au doped Ag nanorod has been synthesized in aqueous medium by a new methodology using CTAC as surfactant at elevated temperature below the boiling point. The length of the nanorod was controlled by varying the amount of CTAC.

It was found that the longest (*NPR_{840}, approximately 840 nm in length*) bimetallic nanorod has the maximum strain within it as confirmed from XRD broadening. Each nanorod is directed towards {110} facet along the length where in the side wise direction was along {111} as confirmed from HRTEM analysis.

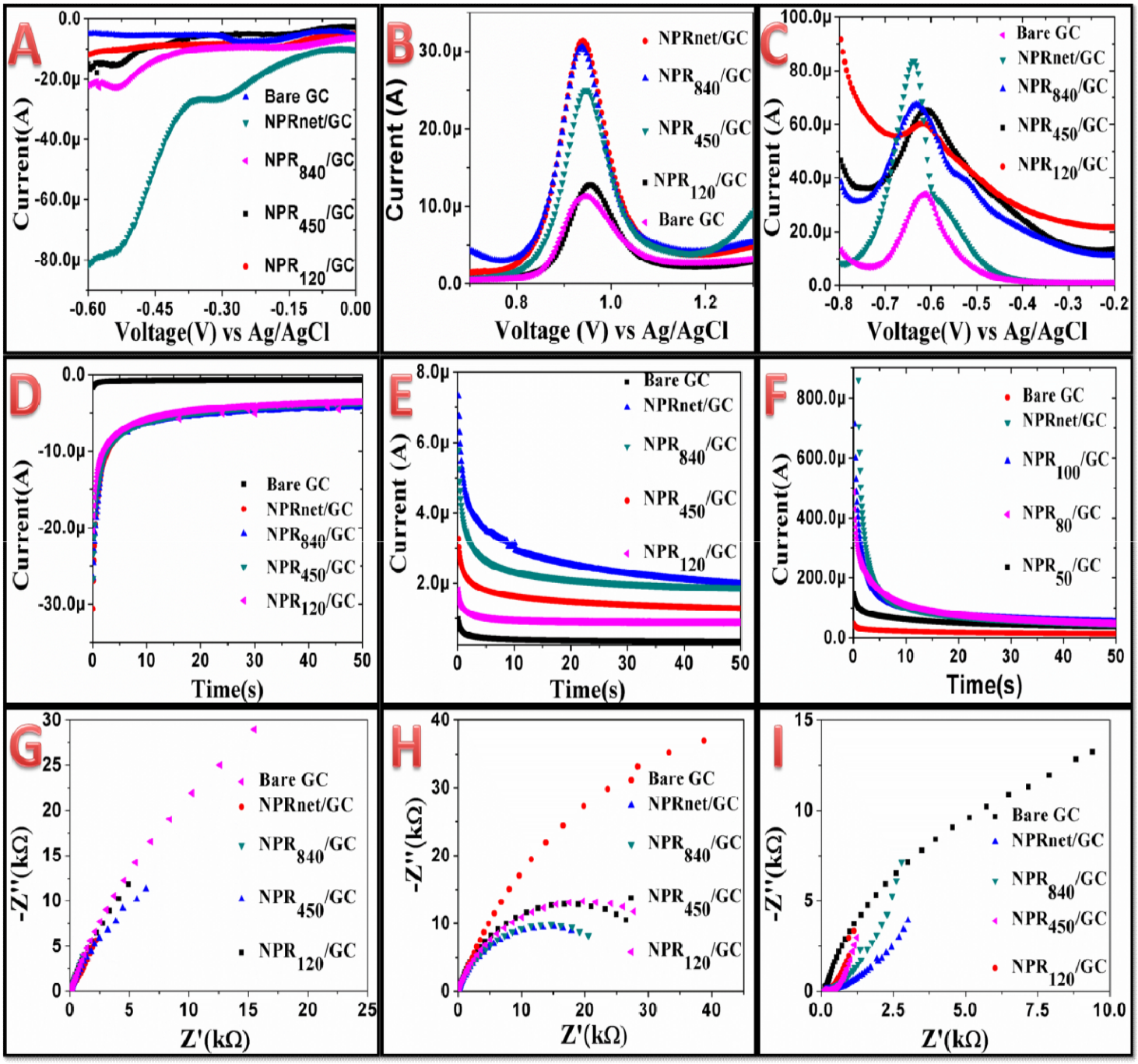
The catalytic activity of these nanorods have been checked by electrochemical performances in different systems & it was found that NPR_{840} has the maximum catalytic efficacy than the shorter ones. The catalytic activity of these nanorods was further improved by cross linking them through thiol chemistry. Au-Ag network (NPRnet) was formed which comprises multiple low coordinated atomic sites like steps, kinks, edges, terraces etc,.

The Au-Ag network was then used as an electrode material for sensing of Dengue serotype related metabolites.



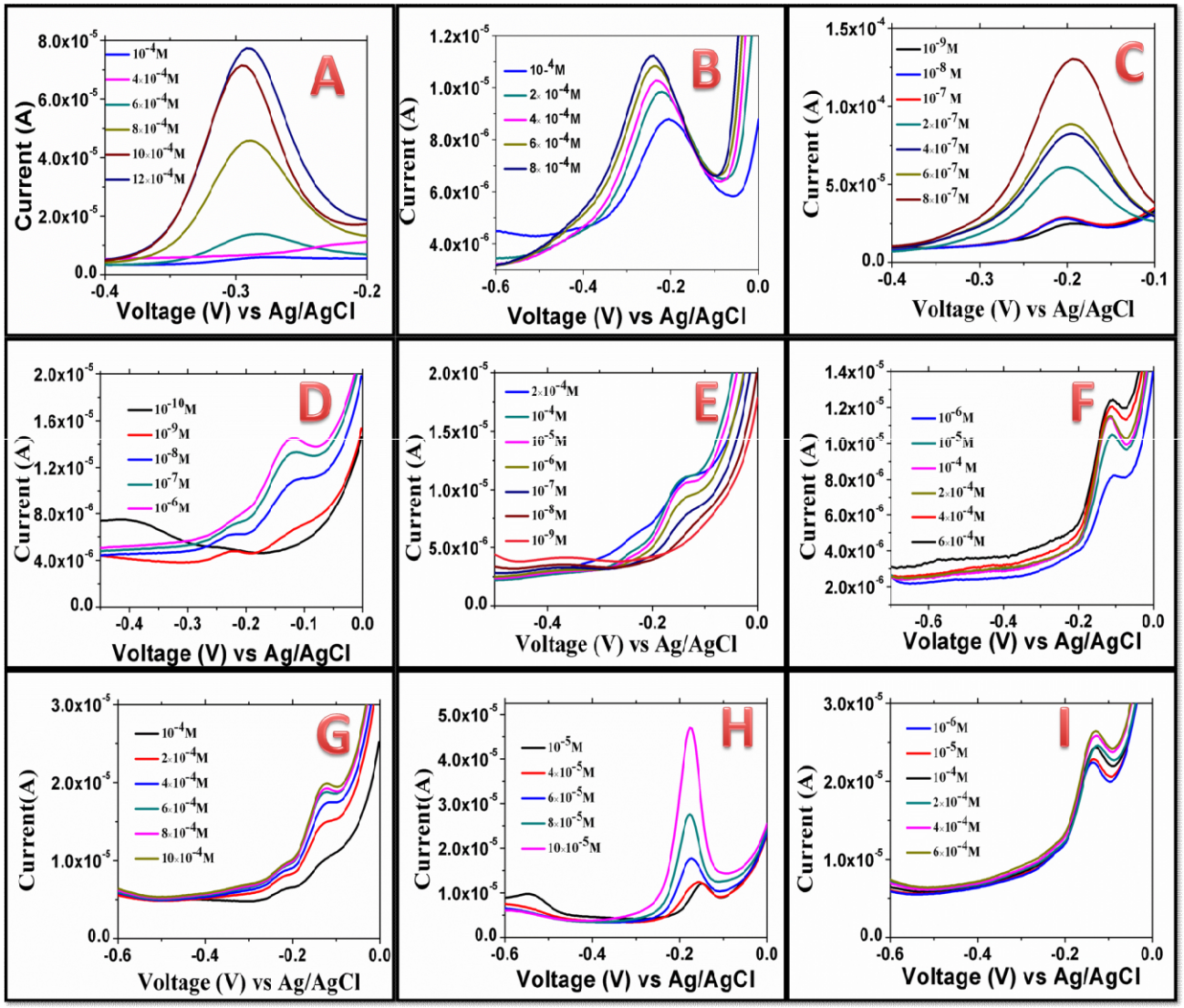
A & D are the SEM images of bimetallic Au-Ag nanorod of different length like 120 and 840 nm. The nanorods are highly monodispersed in nature. B & E are the TEM images where in C and F are the HRTEM images.

G represents the SEM images of highly strained & porous Au-Ag network, where as H is the HAADF image. The elemental mapping is shown in I which clearly shows the existence of Au and Ag.

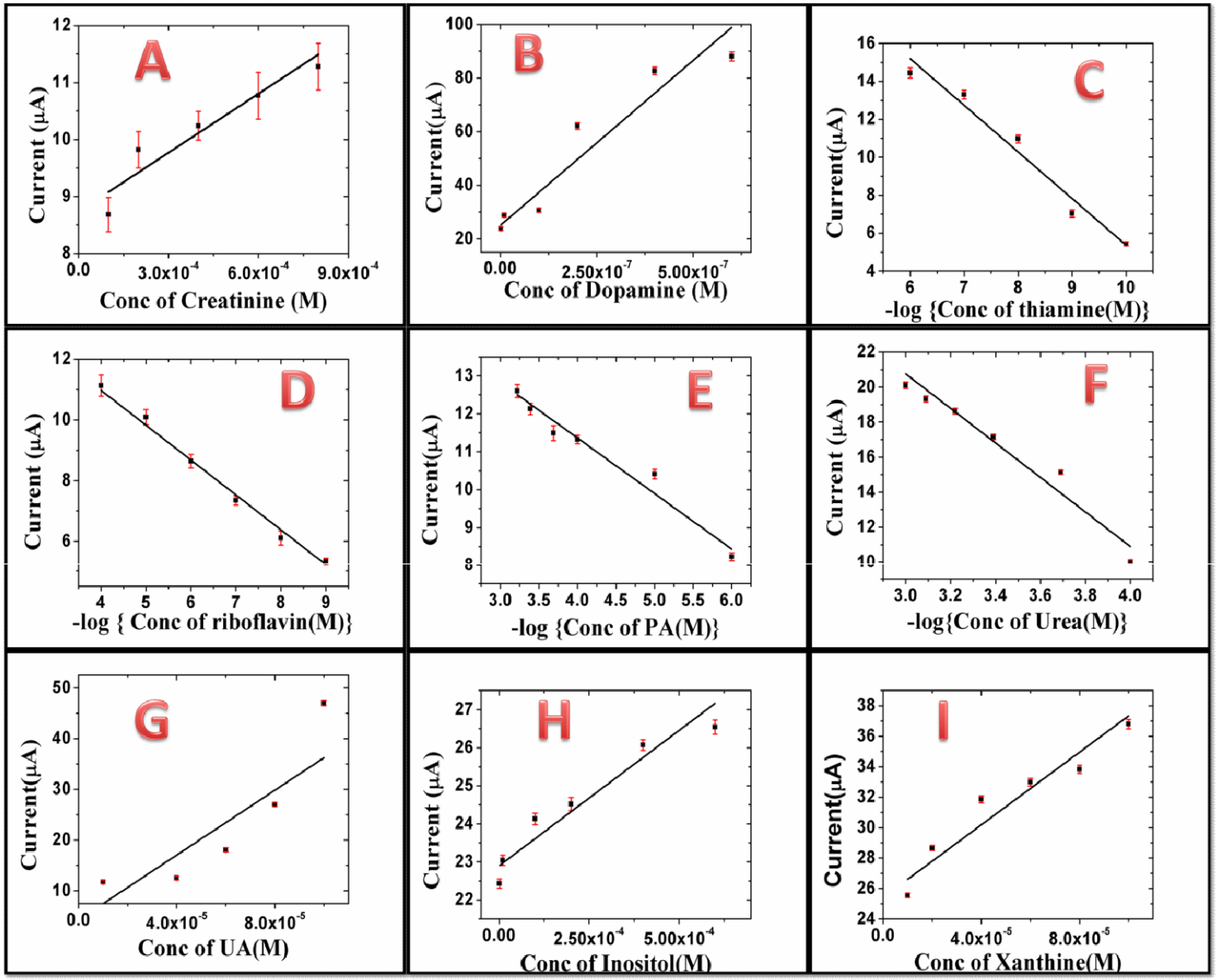


A is the DPV response for the reduction of glucose (4×10^{-4}M) in 0.1M $HClO_4$, B is DPV response for the oxidation of L-tryptophan (4×10^{-4}M) in 0.1M $HClO_4$, C is the DPV response for the reduction of vitamin K3 in 0.1M $LiClO_4$+ acetonitrile. D, E, F are the chroamperometric and G, H, I are the impedance responses of same systems.

High current and low Impedance of NPR_{net} compared to other systems in electrochemical performances encourages us to use it as an electrode material for detection of Dengue serotype-II related metabolites.



Oxidation of metabolites in 0.1M NaOH medium: (A) Ascorbic Acid , (B) Creatinine (C) Dopamine(DA), (D) thiamine, (E) riboflavin, (F) Pantothenic acid (PA) (G) urea (H) uric acid (UA), (I) inositol.



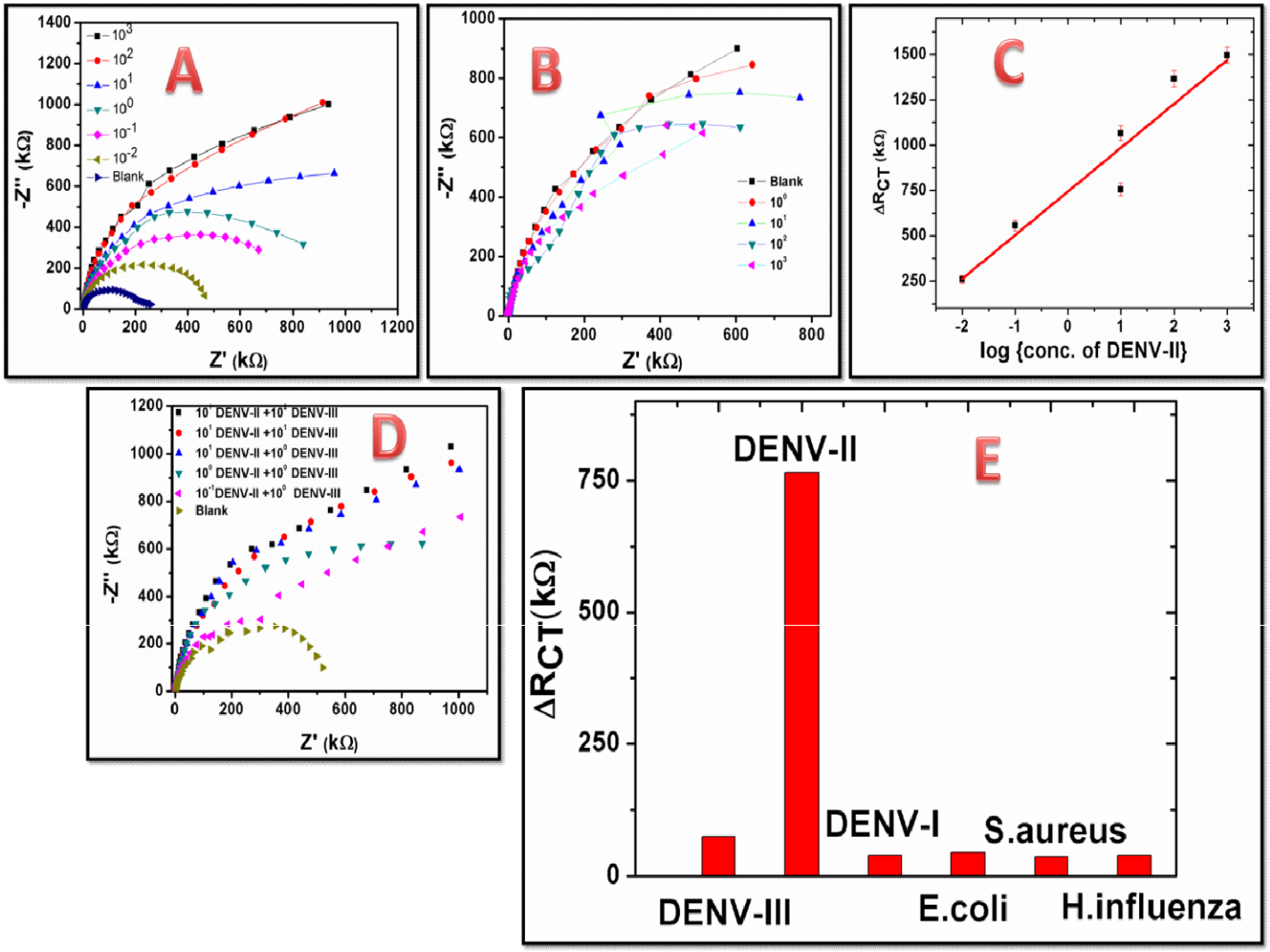
A-I: linear fitting for different water soluble human metabolites as mentioned in the figure during their catalytic oxidation at their physiological concentration level.

The metabolites sensed are directly related to Dengue Srotype-II infected patients.

We have also used the Au-Ag network as an electrode material to detect Dengue-2 by preparing a bioconjugate between NPR_{net} and a specific DNA aptamer against envelope protein of Dengue.

The characterization was carried out by Electrochemical Impedance Spectra where we have used a screen printed electrode as the working electrode. It was found that with increasing Viral load the impedance was increased.

By incorporating Impedance from Nyquist plot into Randless cell resistance of different Dngue-II concentration was determined. From the measurement we have drawn a linear calibration plot between resistance and Dengue-2 concentration. With that calibration, we can easily determine Dengue-II serotypes selectively from unknown sample both qualitatively and quantitatively.



A and B are the Nyquist plot for DENV-II and DENV-III where all the virus concentrations are in PFU/mL unit. C is the calibration plot for DENV-II. D is the cross-reactivity check by impedance response in a mixture of DENV-II+ DENV-III. E is the ΔR_{CT} of DENV-II in a presence of other DENV serotypes and bacteria. For all the samples we used the concentration at 10^1 PFU/mL.

C**onclusion**:

A low cost biosensor has been developed for early detection of Dengue-II & Related metabolites.

The results obtained from our developed techniques are highly reproducible.

This developed method can easily replace the traditional spectrometric, fluoremetric methods in terms od cost, accuracy, and time efficiency.

We are now studying real samples for further applications.