Intelligent Multi-Electrode Array for Real-Time Treatment Monitoring of Antipsychotic Clozapine

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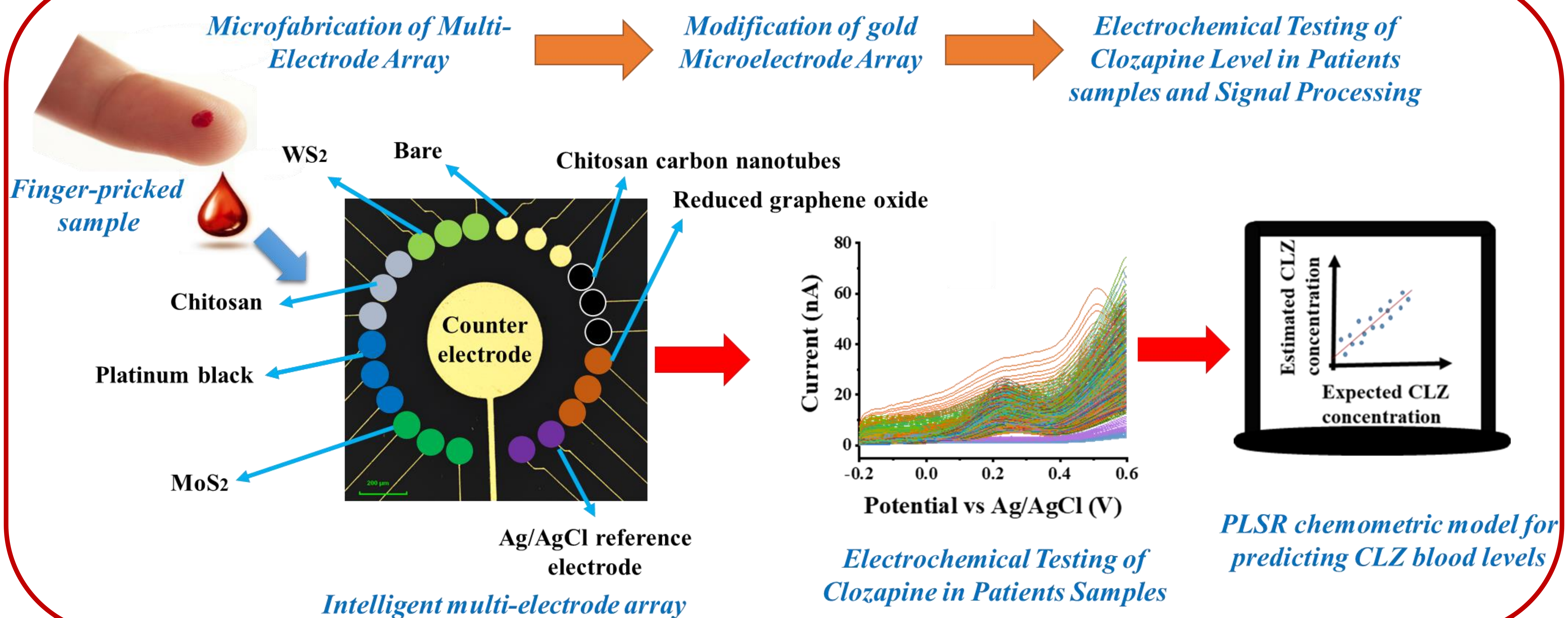
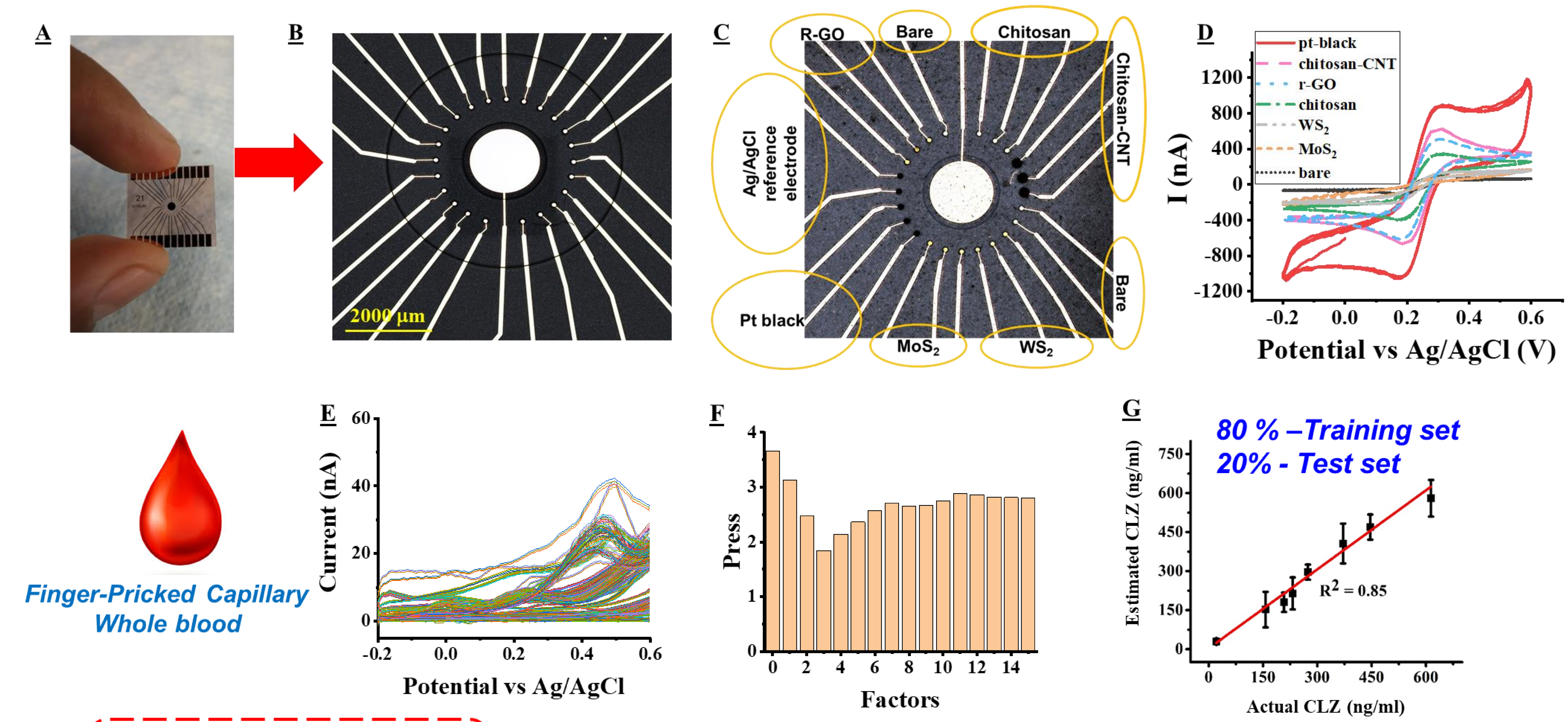
Introduction

Schizophrenia is a challenging mental health disorder.[1] While various antipsychotics have been used to treat schizophrenia, monitoring schizophrenia treatment requires from patients to frequently travel to hospitals in order to test and maintain efficacious levels. Yet, current technologies for antipsychotic drug monitoring require benchtop equipment and long sample preparation time, impeding the ability to rapidly measure various antipsychotics levels at the point-of-care. For example, clozapine is the most effective antipsychotic medication for schizophrenia, but it is dramatically underutilized due to a burdensome monitoring scheme. We propose to overcome the analytical challenges by designing an intelligent multi-sensor array that will be modified with micro/nanometers-thick films.[2] The films are based on 2D materials (reduced graphene oxide, MoS_2 and WS_2) that increase the electrocatalytic activity of the sensors and the underlying variability of the electrochemical signals generated by the antipsychotics. Here, we have shown the development of microelectrodes modified with 2D materials; 2) the development of an intelligent multi-electrode array framework; and 3) the proof-of-concept extraction of antipsychotic levels from schizophrenia patients by using intelligent chemometric models. By rapidly deciphering the electrochemical signals in whole blood and quantifying the levels of the antipsychotics, better schizophrenia treatment outcome can be enabled.

Methodology



Microelectrode array modification and characterization



LoD = 12.6 ± 4.3 ng/ml
PRESS = 1.8 ng/ml

Predicted CLZ blood Levels (ng/ml)	Actual CLZ blood Levels (ng/ml)
438 ± 32.4	450 (1.4 µM)
146 ± 18.3	131 (0.4 µM)

Figure 1. (A) Representative image of the chip, (B) microelectrode array chip with chamber, (C) modified microelectrode array chip, (D) cyclic voltamograms measured in 5 mM ferri/ferrocyanide solution recorded using microelectrode array, (E) differential pulse voltamograms recorded in patients samples using the microelectrode array, (F) predicted residual error some of squares vs factors for the partial least square regression analysis (PLSR), and (G) linear regression analysis for the PLSR model

Conclusions and Future Work

- The microelectrode array allows predicting CLZ levels in microliter volume samples of schizophrenia patients.
- By further integration such sensors in to point-of-care testing devices, Schizophrenia treatment management can be improved.

Acknowledgement

- The authors thank the Ilse Katz Institute for Nanoscale Science & Technology for the help in Microfabrication and material characterization. The authors also thank the Brain and Behavior Research Foundation for funding the project.

References

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