



Fig. 6. The Fully Label-free impedimetric immunosensor chip.

Mostly, the electrochemical cell consist of three electrodes; counter, reference, and working electrodes, to be fabricated using soft photolithography technology. This cell called; also, Microfluidic cell (MFC) and it was developed to have four electrodes instead of three to handle DNA detecting along with bacteria sensing. The core of MFC is interdigitated microelectrodes (IDMA) using Au as a good material for immobilization, and the collector (WCE) and generator (WEG) electrodes; as well, where the reference is made of Ag/AgCl and Pt for counter electrode.

In biomedical applications, dissolved oxygen measurement (DOM) is a key issue. In conventional electrochemical cell that consists of Au working electrode, Pt counter electrode and Ag/AgCl reference electrode; oxygen is reduced at the working electrode and released at the counter electrode. In such case where large distance between the working electrode and the counter electrode is strongly presented the response of the sensor is inadequate, thus, redox cycling does not achieve the target in biomedical applications. Credit for MEMS microfabrication techniques this issue is resolvable, where micro/nanotechnology is employing to fabricate tiny devices with very narrow gaps, which is a proper geometry for redox cycle to occur.

The narrowest gap between the working and counter electrodes the highest opportunity for redox cycle to increase, the biomedical particles that be inherent in the gap between microelectrodes can be readily detected; accordingly. MEMS technology allows measuring the amplification factor where the conventional techniques cannot. The amplification factor is the ratio of the redox cycling current flowing through the working electrodes to the current flowing through the reference electrode. In addition; to improve the mechanism of the redox cycle where interdigitated microelectrodes array are used in the electrochemical cell, a four microelectrodes are replaced instead of three electrodes. These microelectrodes are Working Electrode Collector (WEC), Working Electrode Generator (WEG), counter electrode, and reference electrode as shown in Fig. 6. Throughout the operation of the four-microelectrode configuration, where WEC and WEG are very close to each other, the redox cycling process can easily perform in a reversible operation; such as holding WEG at potential to drive the reduction, at the

same time as holding WEC at potential to drive the oxidation [29].

Biosensors based amperometric sensors incorporating with interdigitated microelectrodes arrays (IDMA) are powerful technique for detecting biomolecules. The performance and high sensitivity of the biosensor rely on minimum gap between the fingers, which eventually lies on the fabrication process. In the other hand, the biosensor is limited by the capability of the biomolecules to be reversible redox cycling and the threshold space that require to perform the detection for the what wanted and undesirable reactions that cannot be avoided.

The patient usually suffers from either excess (hyperthyroidism) or deficiency (hypothyroidism) of thyroid hormone; T4/T3, therefore, testing sample of the patient blood to determine the level of thyrotropic hormone (TSH), which its standard reference range between 0.4 and 5.0 $\mu\text{IU/mL}$ for adults. The curative target range TSH level for patients on treatment ranges between 0.3 to 3.0 $\mu\text{IU/L}$.

IV. CONCLUSION

The new configuration will help to detect the level of TSH and in the light of the result, a proper dose will recommend by the physician to the patient to bring him to the normal activity with no suffering from any symptom of this disease. The performance of the biosensor is achieved by adding the two working electrodes. MEMS technology allows fabricating tiny features to perform a reversible process of redox cycling. The IDMA are essential to be embedded in the MFC for detecting the biomolecular sample.

REFERENCES

- [1] Park, S. M Yoo, JS; Chang, BY; Ahn, ES, "Novel instrumentation in electrochemical impedance spectroscopy and a full description of an electrochemical system", *Pure and Applied Chemistry* 78 (5): 1069-1080, MAY, 2006.
- [2] Chang, B.-Y.; Park, S. M., "Theory and applications of real-time electrochemical impedance spectroscopy measurements", 213th ECS meeting Abstracts 2008, 2, 1136-2008.
- [3] Byoung-Yong Chang , Su-Moon Park, "Integrated Description of Electrode/Electrolyte Interfaces Based on Equivalent Circuits and Its Verification Using Impedance Measurements", pp 1052-1060, December 24, 2005.
- [4] Jin-Young Park, Byoung-Yong Chang, Hakhyun Nam, Su-Moon Park, "Selective Electrochemical Sensing of Glycated Hemoglobin (HbA1c) on Thiophene-3-Boronic Acid Self-Assembled Monolayer Covered Gold Electrodes", pp 8035-8044, Oct 1, 2008.
- [5] Jin-Young Park, Su-Moon Park, "DNA Hybridization Sensors Based on Electrochemical Impedance Spectroscopy as a Detection Tool", *Sensors*, 9, 9513-9532, 2009.
- [6] Mehrab Mehrvar Mustafe Abdi, "Recent developments, characteristics, and potential applications of electrochemical biosensors", *Analytical Sciences* Vol. 20, No. 8 p.1113, 2004.
- [7] Tomoko Kimura, Keiko Nakanishi, Terumichi Nakagawa, Akimasa Shibukawa, Katsumi Matsuzaki, "Simultaneous determination of unbound thyroid hormones in human

