Electro-Active Single Mode Integrated Optical Waveguide Application in Spectroelectrochemistry

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Abstract:

High sensitive electro-active single mode integrated optical waveguide (IOW) was designed, fabricated and optimized for spectroelectrochemistry application. In traditional electrochemistry analysis, faradaic current suffers from a huge background caused by double layer charging current. In contrary, optical signal is only related to the absorbance change from redox species states switching happening at electrode/electrolyte interface which is driven by applied potential modulation and any other processes happening in the bulk solution have no influence. And an electro-active single mode IOW provides even more sensitivity because of its much longer light/material interaction distance among various optical probing strategies.

Two 323-nm pitch size gratings, fabricated on cleanroom cleaned soda lime glass slides, were used as broadband light couplers; 400-nm high quality alumina and 16-nm silica, coated by atomic layer deposition (ALD), was used as single mode waveguide in visible range; and 13-nm indium tin oxide (ITO), coated by DC pulsed sputtering, was used as electro-active layer. Structure of this sensor and electrical connection are demonstrated in figure 1.

Cytochrome-c redox reaction kinetics under alternating current (AC) potential modulation was examined. Since high sensitivity of IOW, sub-monolayer active cytochrome-c surface coverage could be detected easily. 25 s^{-1} standard reaction rate constant was resulted.

Combined with electrical function, a single mode IOW has great potential in studies in ultra-small amount of redox species, like for natural redox proteins; new chemicals, like for new medicine characterization; or nano-particles, like for increasing solar cell efficiency, and other applications.

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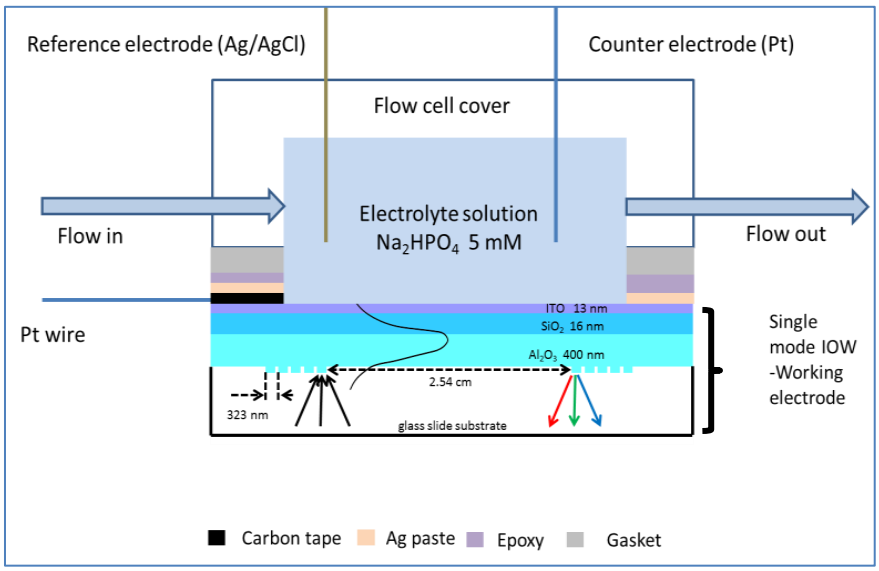

Figure 1: Demonstration for spectroelectrochemistry flow cell.