In this thesis, a special characterization method for evaluating the feasibility for MFC anode electrode material has been developed by monitoring the feedback current above the biofilm adhered on electrode surface using scanning electrochemical microscopy (SECM).

Firstly, the relationship between electrogenic ability and biofilm morphology of an electrogenic model species Shewanella oneidensis MR-1 was studied using SECM with reference to conventional electrochemical characterization, optical imaging and SEM. The time-lapse SECM areascal characterization has proved to be able to profile the temporal change of bacteria-electrode coupling status, which is a combination property of biofilm morphology and electrogenic ability. The heterogeneity of biofilm has been discovered with SECM technique.

Then this technique has been applied to monitor morphologically and/or compositionally heterogeneous electrode, using polypyrrole-coated electrode and partially metal-sputtered electrode for demonstration. A subtraction process was utilized to eliminate the feedback effect from the substrate; and the consistency between SECM, SEM and other groups’ reports on MFCs using anode electrode made of the corresponding material, proved the accuracy of this subtraction process. It has thus proved that the monitoring electrogenic bacterial biofilm-electrode coupling status could be used for MFC anode electrode materials evaluating within a relatively short experimental time, compared to using the conventional MFC output test.

After all, two types of materials screening platform prototypes intended for conducting polymer and metal have been fabricated using two reproducible methods-electropolymerization and photolithography, respectively. And they were used as anode electrode for bacterial electrogenic experiments. It has been observed that the on the same screening platform, the bacteria adherence is locally determined by the different surface material candidates assembled onto the platform; and the relative biofilm density on different miniaturized region is same as that on the correspondent bulky. Hence, this screening platform configuration could accurately reflect the biofilm-facilitating property of each assembled material on the screening platform. It has also been found that a time limit needs to be exceeded for electrogenic experiment to achieve stable feedback current difference among the heterogeneous substrate for SECM monitoring technique.