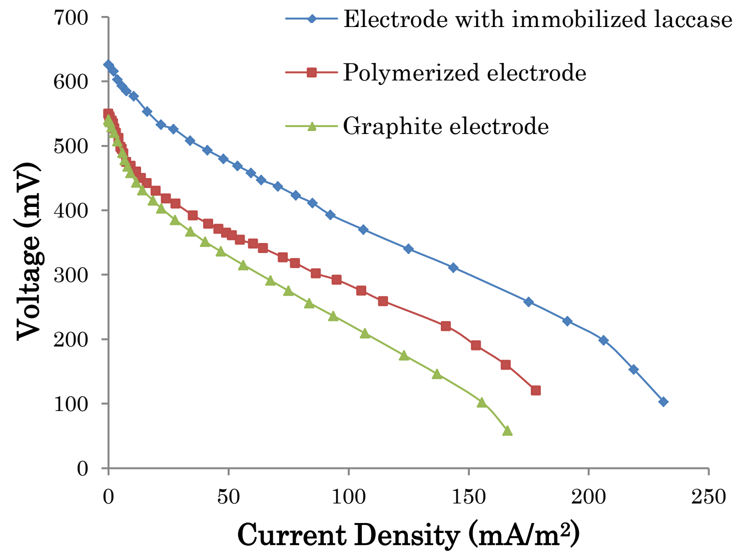

Fig. 2. Polarization curve of MFC with three different electrodes.

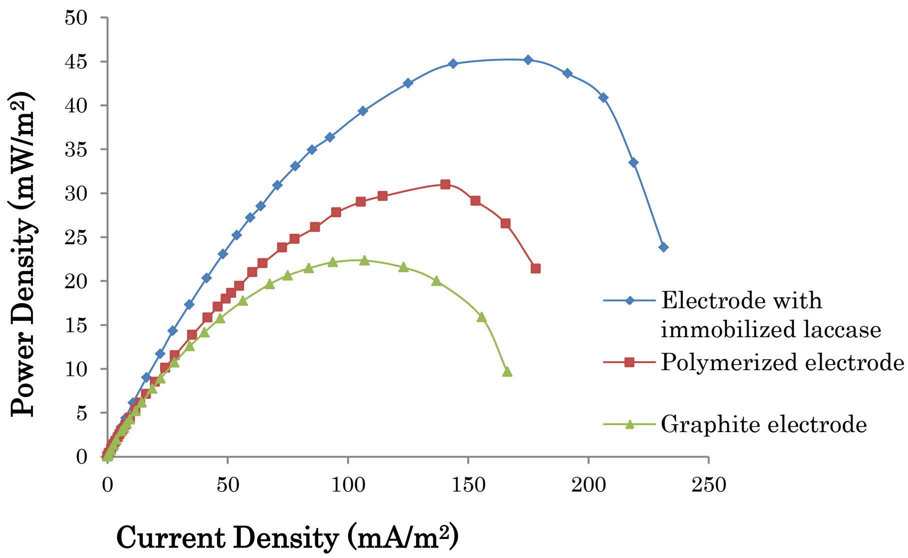

Fig. 3. Power density curve of MFC with three different.

3.3. MFC performance in the presence of MnP

The time course of open circuit voltage variation of the MFC after addition of H_2O_2 is shown in Fig. 4. After H_2O_2 addition, the voltage rapidly increased to a maximum value and then gradually decreased to a constant value. The voltage increase is related to a higher cathodic potential of H_2O_2 compared to oxygen potential. The MFC performance during this stable condition is shown in the polarization and power curves (Fig. 5 and Fig. 6). Maximum output power of 46 mW/m^2 was obtained at current density of 108.8 mA/m^2. This power density is 106% higher than that for a non-enzymatic cathode. The slope of polarization curve for MnP with immobilized MnP cathode at low current densities is 54% less than that for the non-enzymatic cathode. Therefore, MnP presence in the cathode reduces cathodic and overall activation overpotential which is attributed to the catalytic role of MnP in the cathode.

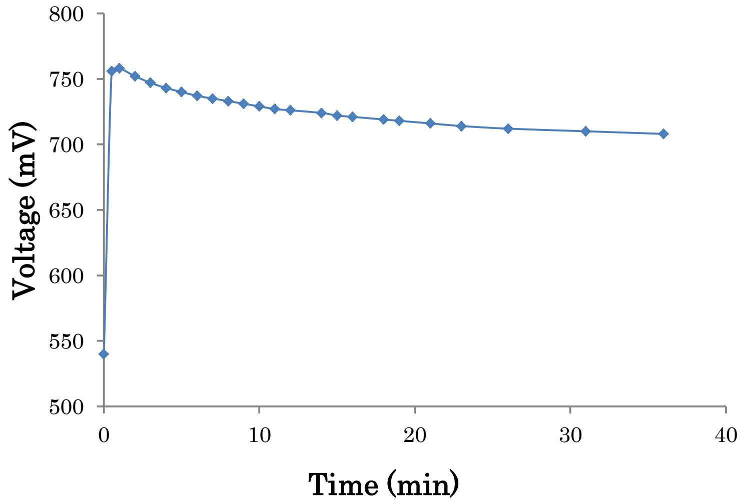

Fig. 4. Open circuit voltage-time curve of MFC after H_2O_2 addition to the cathode in the presence of MnP.

MnP can catalyze hydrogen peroxide reduction to water. Reduction of H_2O_2 causes the oxidation of heme group of the enzyme. The oxidized heme group needs to be reduced to keep its activity which can be fulfilled electrochemically or by an electron donor molecule. Here, Mn^{2+} acts as electron donor. Electrons generated through Mn^{2+} oxidation will be transferred to the active sites of the enzyme and will be utilized to reduce H_2O_2 to water. The produced Mn^{3+} ions extract electrons presented on the cathode surface. The cathodic reaction is catalyzed by MnP enzyme through repetition of the mentioned reactions, cyclically.

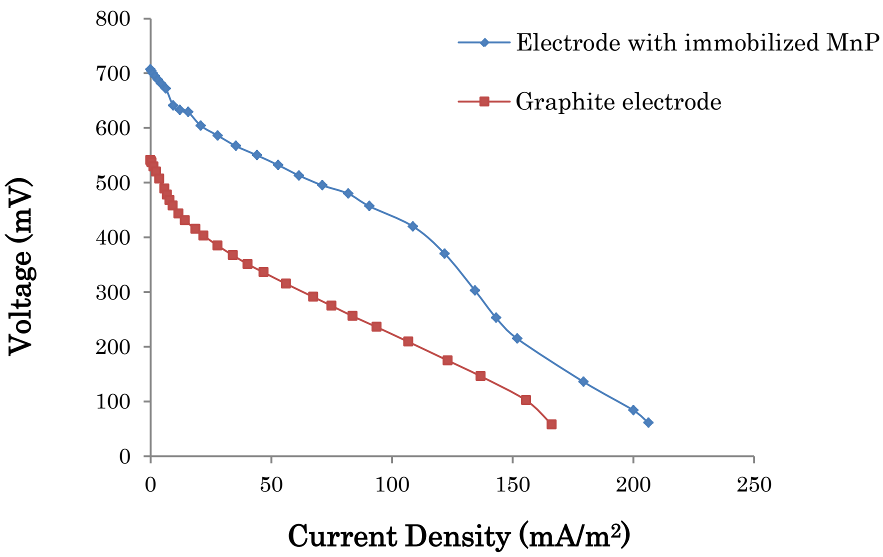

Fig. 5. Polarization curve of MFC with two different electrodes.

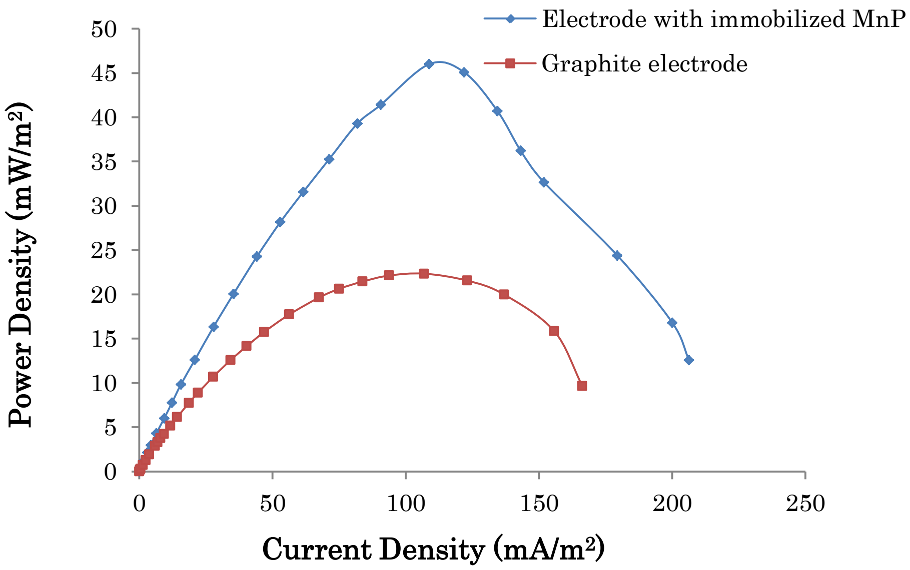

Fig. 6. Power density curve of MFC with three different electrodes.

4. Conclusion

Commercial laccase and MnP produced from a white rot fungus isolate were immobilized on graphite electrode and used as new renewable catalysts in the cathode compartment of a dual chamber MFC. Application of these electrodes in the cathode, enhanced the MFC performance. Output voltage and current density increased as two times as output voltage of the MFC with non-enzymatic cathode. Activation overpotential of MFC decreased due to the catalytic effect of laccase and MnP on reduction of oxygen and H_2O_2, respectively. Laccase and MnP can be proposed as innovative catalysts to be applied in MFCs in order to achieve higher performance via improvement of reaction kinetic in the cathode and therefore, reduction of its related overpotential.

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