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On the determination of the catalytic activity of oxygen reduction reaction in polymer electrolyte membrane fuel cell (PEMFC).

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Platinum supported on high surface area carbon substrate (e.g Vulcan XC72) is the most widely used electrocatalysts in low temperature polymer electrolyte fuel cells (PEMFC). Unfortunately the oxygen reduction reaction show strong kinetic inhibition and therefore high over-potential which is considered to be the limiting factor in the development of PEMFC. The catalytic activity of ORR is usually determined using a kinetic current density i_k which is determined from the Kouecky-Levich type analysis according to: $i_k = i_d I_l / [i_l - i_d]$ where I_d is the disk current and I_l is the limiting current both determined from rotating ring disk electrode (RRDE) at enough rotation to suppress mass transfer effects. The purpose of this work is to show that the limiting current density I_l determined from RRDE can be used to compare the catalytic activity of the ORR and is better criterion than the kinetic current i_k. The kinetic current is usually evaluated from the RRDE data in the mixed region where both kinetics and diffusion resistance are important. However, the limiting current is proportional to the mass transfer coefficient in the flux equation and in fact the surface concentrations at the catalyst surface can only be determined if the limiting current density is known. Furthermore, it is the limiting current which is the disk or experimentally measured current but at enough rotation so that mass transfer resistance is eliminated. Some experimental data from various investigators will be given to support the above.