Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics

Synthesis and electrocatalytic activitiy of highly porous hollow palladium nanoshells for oxygen reduction in alkaline solution

Yun-Bin Cho,[a] Ji Eon Kim,[a] Jun Ho Shim,*[a,b] Chongmok Lee,[a] and Youngmi Lee*[a]

[a]Department of Chemistry & Nano Science, Ewha Womans University, Seoul 120-750, Korea

[b]Department of Chemistry, Daegu University, Gyeongsan 712-714, Korea

*To whom all correspondence should be addressed: youngmilee@ewha.ac.kr (Y. Lee) and junhoshim@daegu.ac.kr (J. H. Shim)

Tel: (+82) 2-3277-6652; Fax: (+82) 2-3277-2384

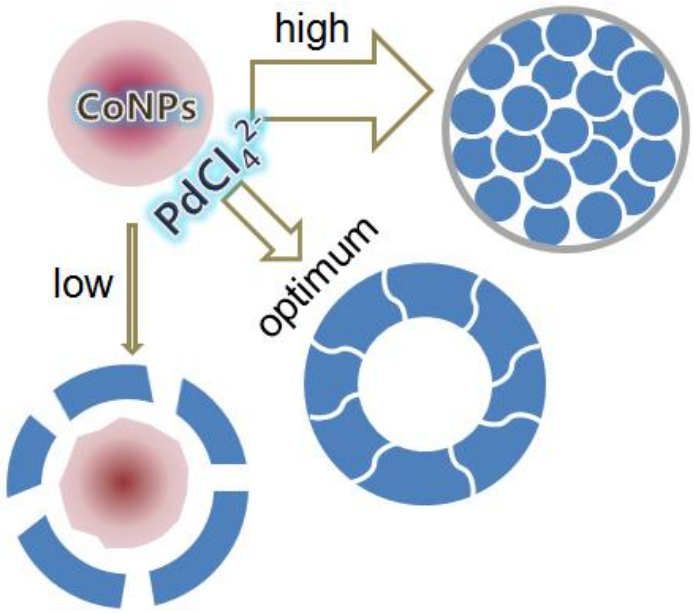

Fig. S1. Schematic illustration of the hPd nanoshells prepared at different concentrations of palladium precursor.

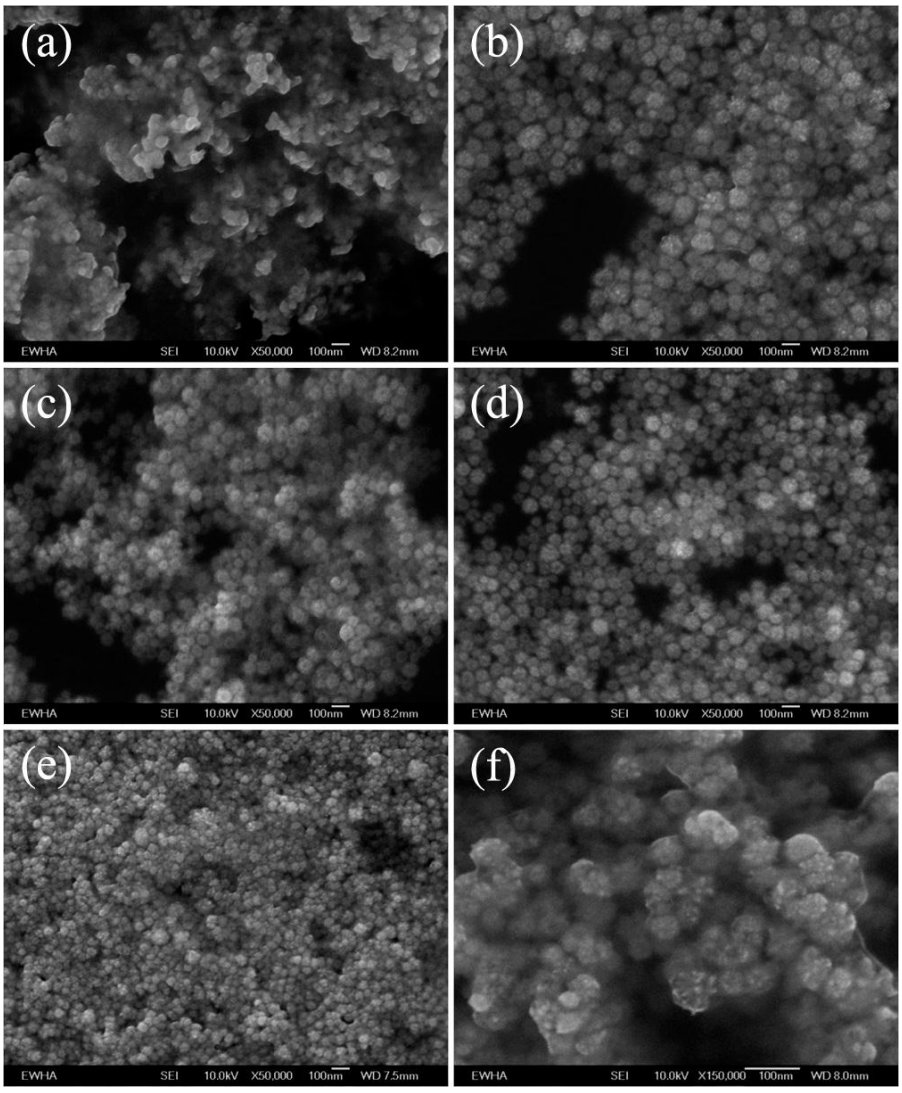

Fig. S2. Representative SEM images of palladium nanoshells obtained by reacting cobalt nanoparticles with an aqueous K_2PdCl_4 solution ((a) 1 mM, (b) 6 mM, (c) 12 mM, (d) 20 mM, and (e and f) 40 mM). Panel (f) is a higher-magnified view of a sample (e).

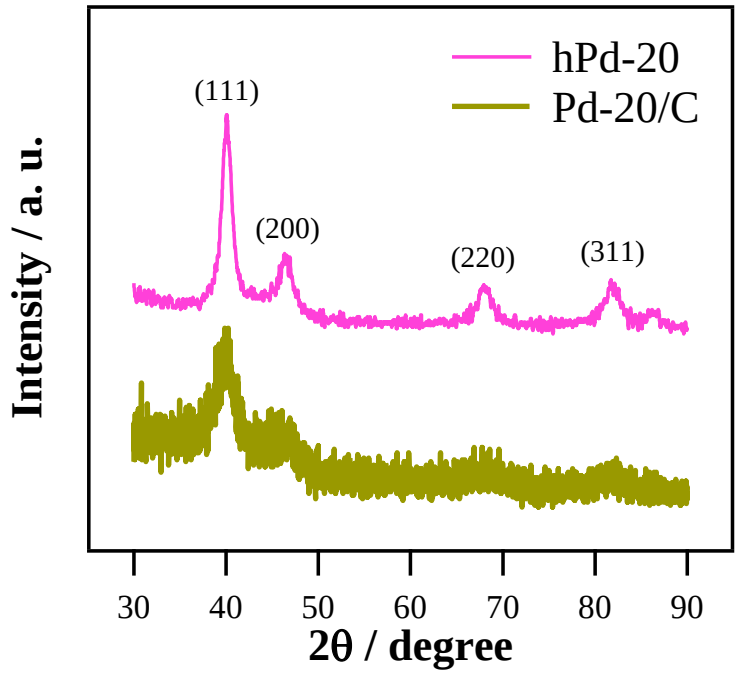

Fig. S3. XRD patterns of hPd-20 and commercial Pd-20/C.

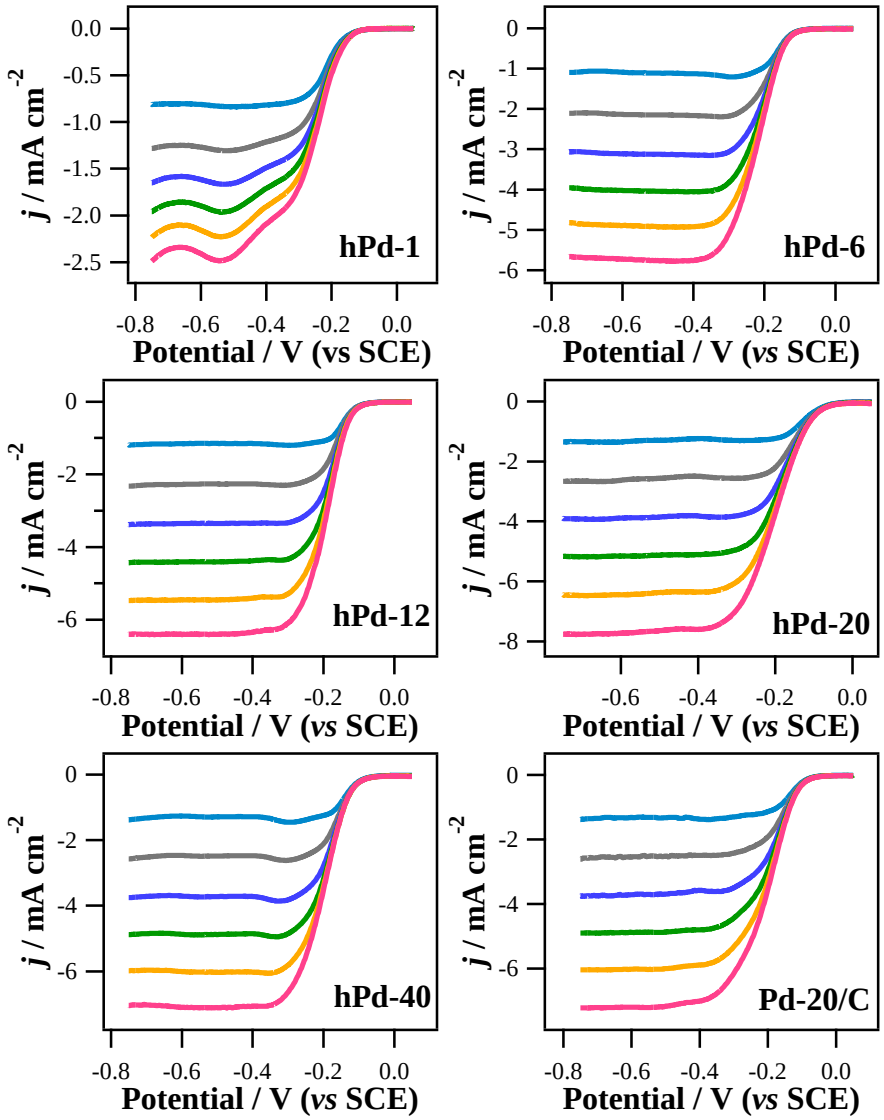

Fig. S4. RDE voltammograms for oxygen reduction in an O_2-saturated 0.1 M NaOH at the hPd-1, hPd-6, hPd-12, hPd-20, hPd-40, and Pd-20/C loaded GC electrodes at a scan rate of 10 mV s^{-1} with a rotation speed of 100, 400, 900, 1600, 2500 and 3600 rpm.

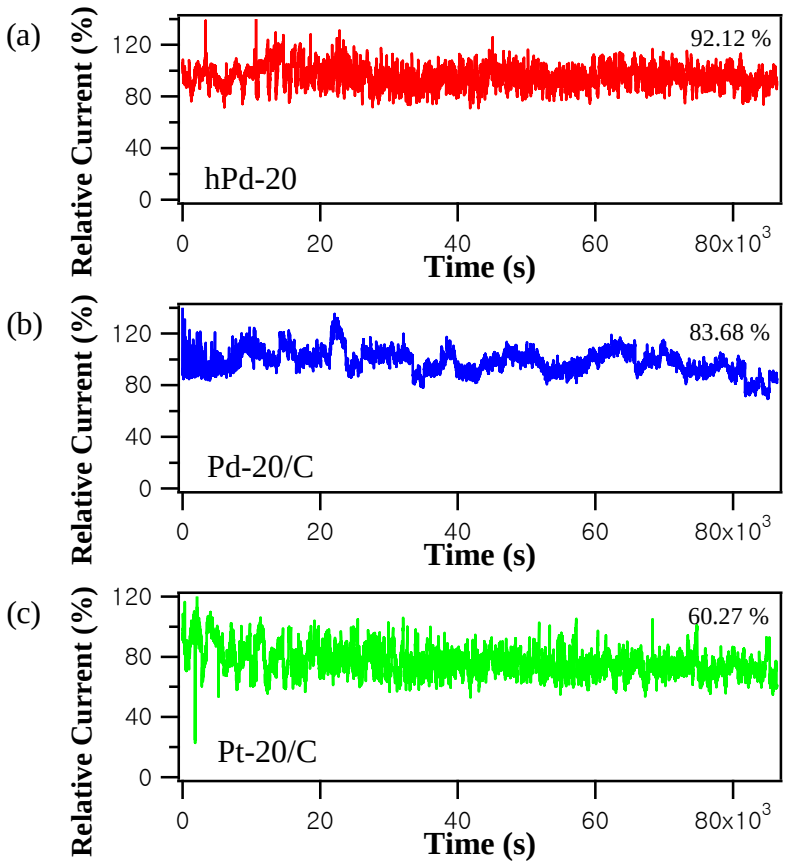

Fig. S5. The steady-state currents measured continuously for hPd-20, Pd-20/C, and Pt-20/C-loaded GC electrodes at –0.5 V vs. SCE in an O_2-saturated 0.1 M NaOH solution, magnetically being stirred.

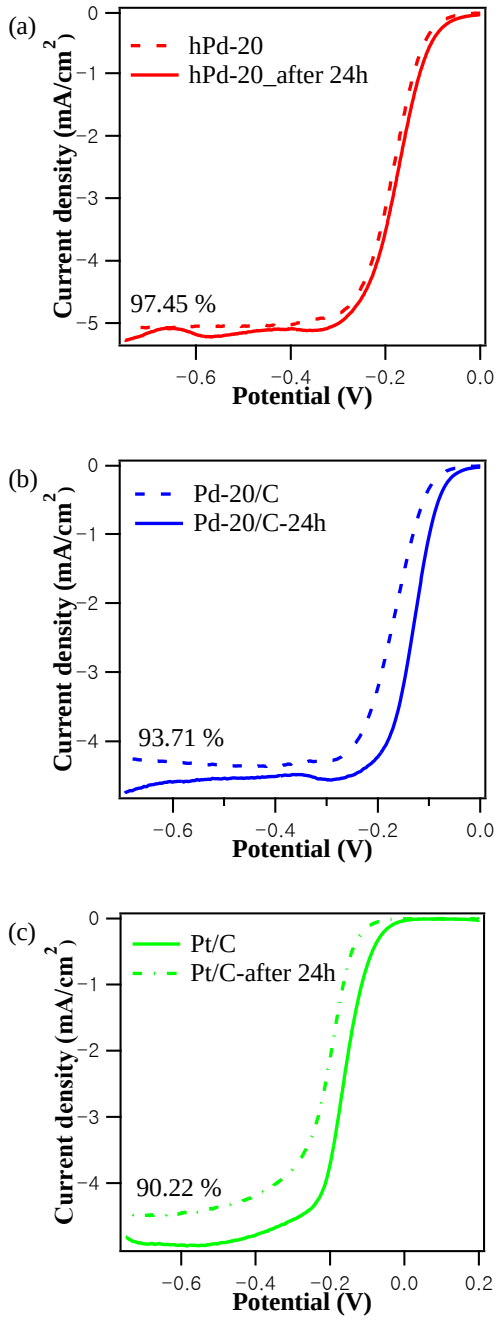

Fig. S6. RDE voltammograms before and after 24-h continuous chronoamperometric measurements (Fig. S5) obtained with hPd-20 (a), Pd-20/C (b), and Pt-20/C (c) -modified GC electrode in an O_2-saturated 0.1 M NaOH solution at a rotation rate of 1600 rpm and a scan rate of 10 mV s^{-1}.

Table S1. Mass activities of hPd-20 with and without carbon support, commercial Pd and Pt catalysts.

	Current (mA)[a]	**Relative current (%)**	**Mass activity (mA μg_{metal}^{-1})**
hPd-20	–0.580	100	0.0290
hPd/C-20wt%	–0.494	85.2	0.124
hPd/C-15wt%	–0.385	66.4	0.128
Pd-20/C	–0.422	72.8	0.106
Pt-20/C	–0.388	66.9	0.0970

[a] The values are the limiting currents measured at –0.7 V vs. SCE in the RDE curve for ORR obtained with a rotation speed of 1600 rpm.