Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Improved catalytic activity in methanol electro-oxidation over nickel form of aluminum-rich Beta-SDS zeolite modified electrode

Yanmei Liao[a], Shuxiang Pan[b], Chaoqun Bian[b], Xiangju Meng[b], and Feng-Shou Xiao[b]*

[a] *State Key Laboratory of Inorganic Synthesis and Preparative Chemistry, Jilin University, Changchun, 130012, China*

[b] *Key Lab of Applied Chemistry of Zhejiang Province and Department of Chemistry (Xixi Campus), Zhejiang University, Hangzhou, 310028, China*

E-mail: fsxiao@zju.edu.cn

Experimental

Characterization. X-ray diffraction (XRD) patterns were measured with a Rigaku Ultimate IV diffractometer using Cu *Kα* radiation. Scanning electron microscopy (SEM) images of the samples were performed on a Hitachi SU 1510 apparatus. Nitrogen sorption isotherms at -196 ºC were obtained with a Micromeritics ASAP 2020M system. The Si/Al ratios of the samples and loading of Ni^{2+} were measured by inductively coupled plasma (ICP) with a Perkin-Elmer optima 8000 emission spectrometer.

Electrochemical Measurements: The electrochemical tests were performed using the electrochemical workstation CHI660D (Shanghai Chenhua Instrument Co., Ltd., China). A three compartment electrochemical cell was employed using Hg/HgO as

the reference electrode, a platinum foil as the auxiliary electrode, and zeolite modified glass carbon electrode as the working electrode.

Table S1. Beta-SDS zeolites with various loadings of Ni^{2+} species in the as-synthesized samples

Sample	Si/Al	Ni^{2+} (wt.%)
Ni-Beta-SDS-0.9	4.5	0.9
Ni-Beta-SDS-2.1	4.9	2.1
Ni-Beta-SDS-4.2	5.0	4.2
Ni-Beta-SDS-5.1	5.0	5.1
Ni-Beta-SDS-6.6	5.0	6.6
Ni-Beta-SDS-7.0	5.0	7.0

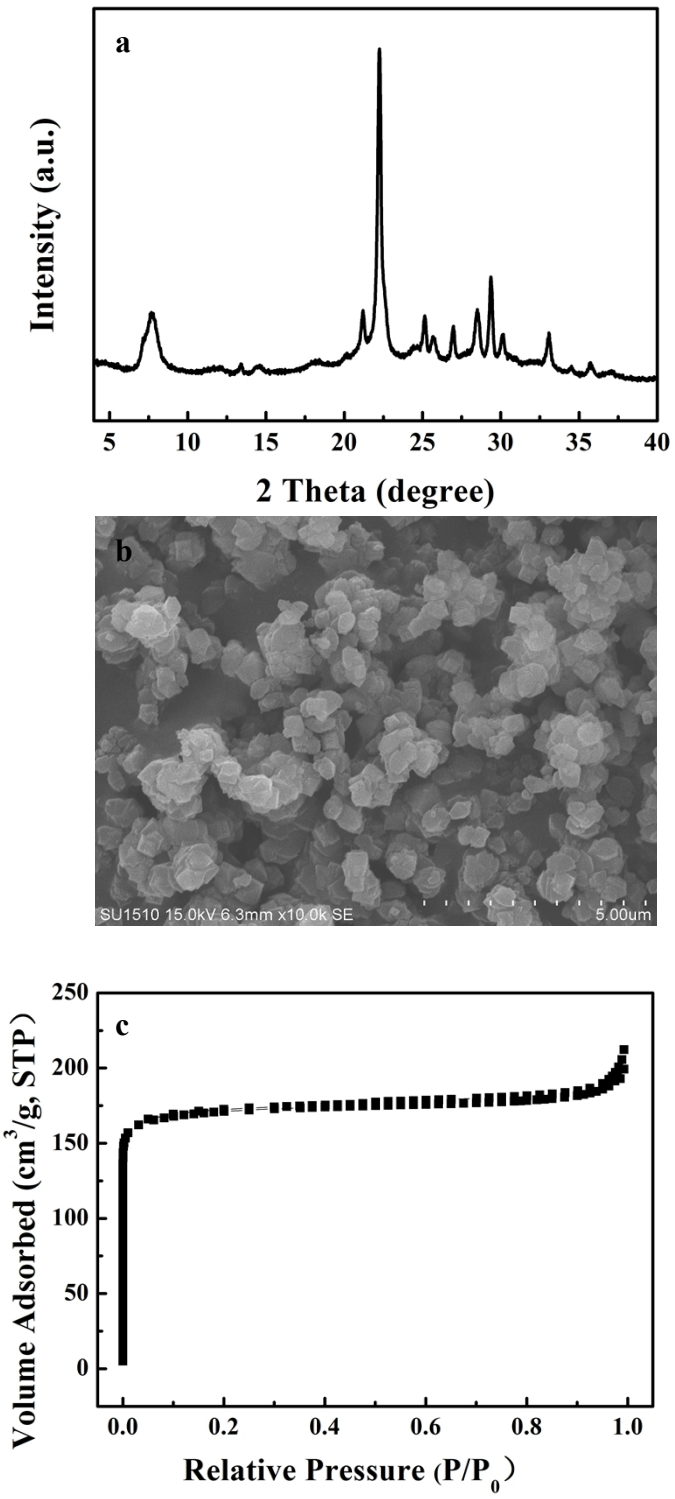

Figure S1. (a) XRD pattern, (b) SEM image and (c) nitrogen sorption isotherms of Beta-SDS sample.

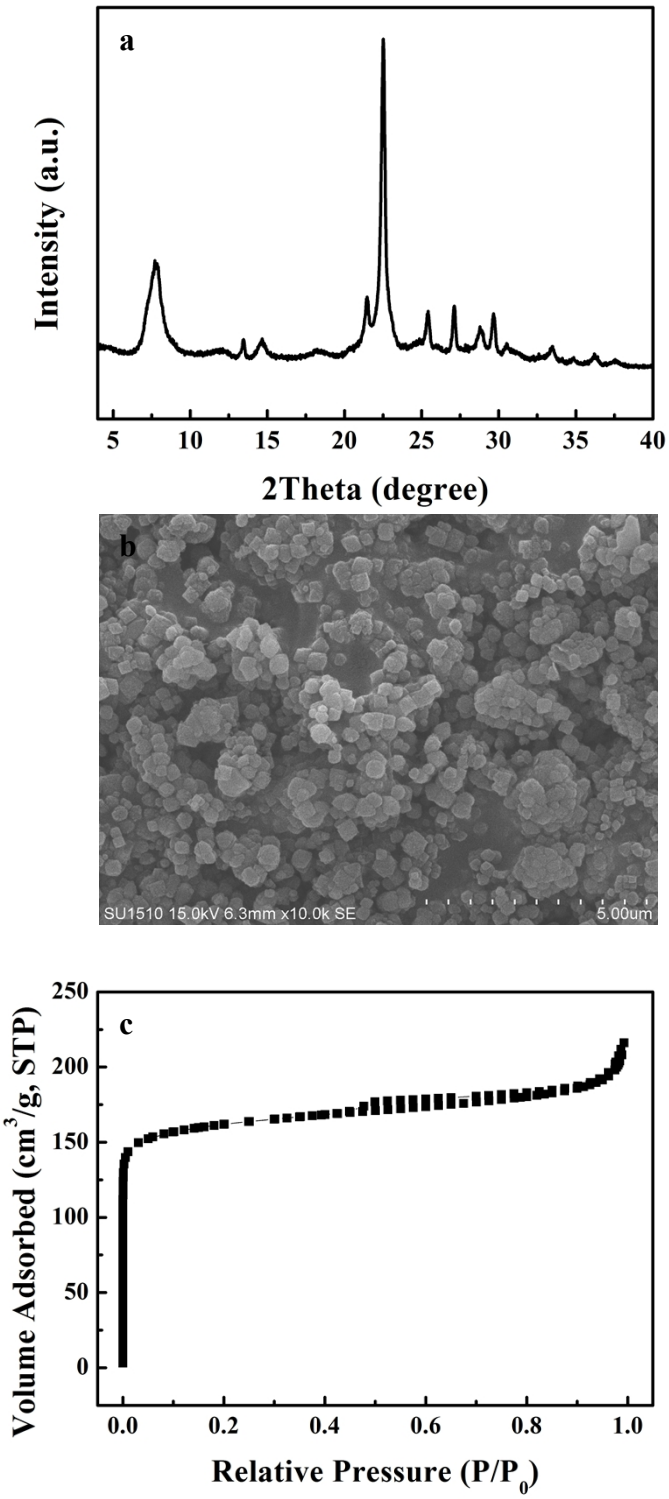

Figure S2. (a) XRD pattern, (b) SEM image and (c) nitrogen sorption isotherms of Beta-TEA sample.

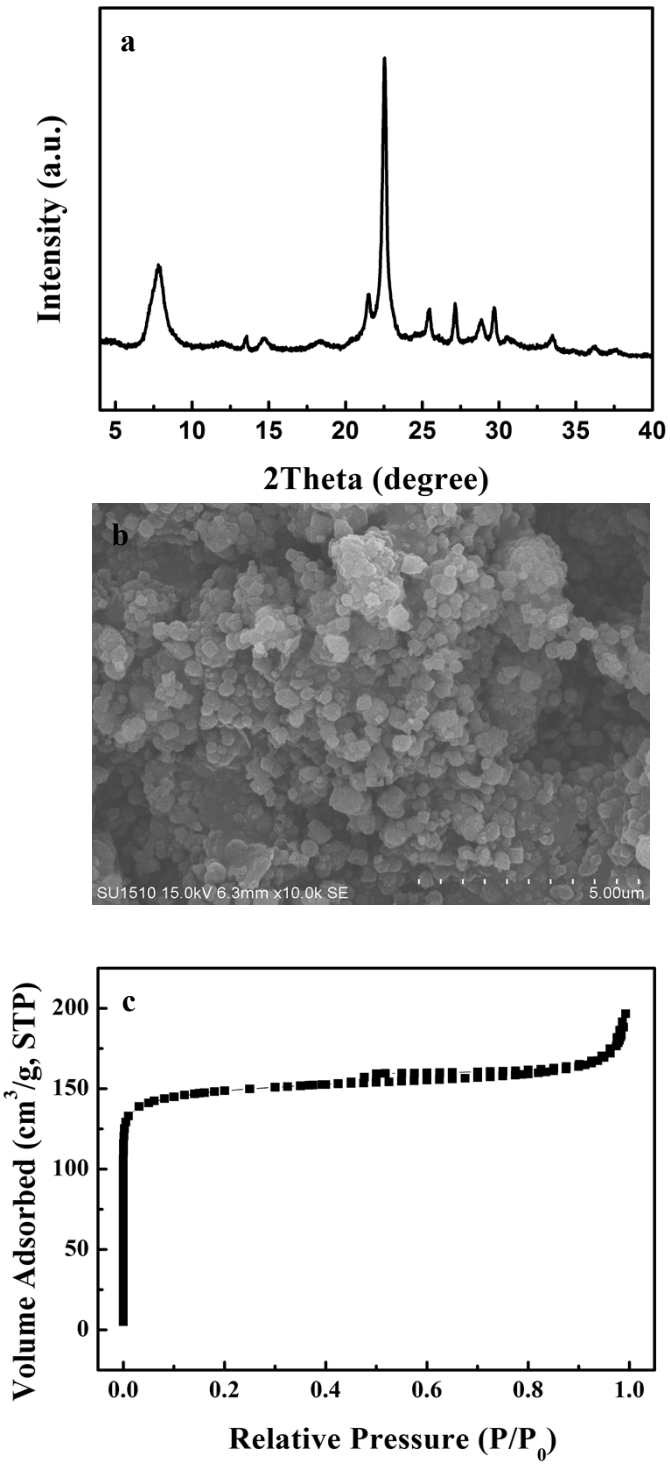

Figure S3. (a) XRD pattern, (b) SEM image and (c) nitrogen sorption isotherms of Ni-Beta-TEA sample.

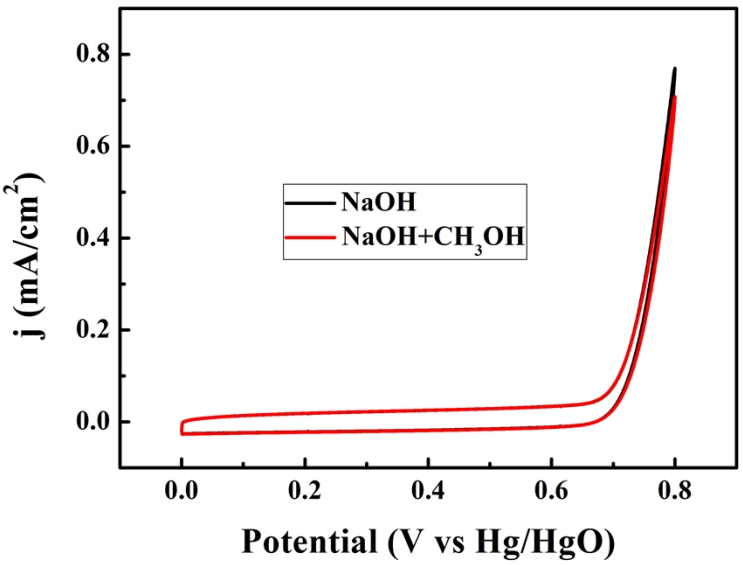

Figure S4. Cyclic voltammograms of Beta-TEA zeolite modified electrode in 0.1 M NaOH and in a mixture of 0.1 M NaOH with 0.1 M CH_3OH at scan rate of 50 mV/s.

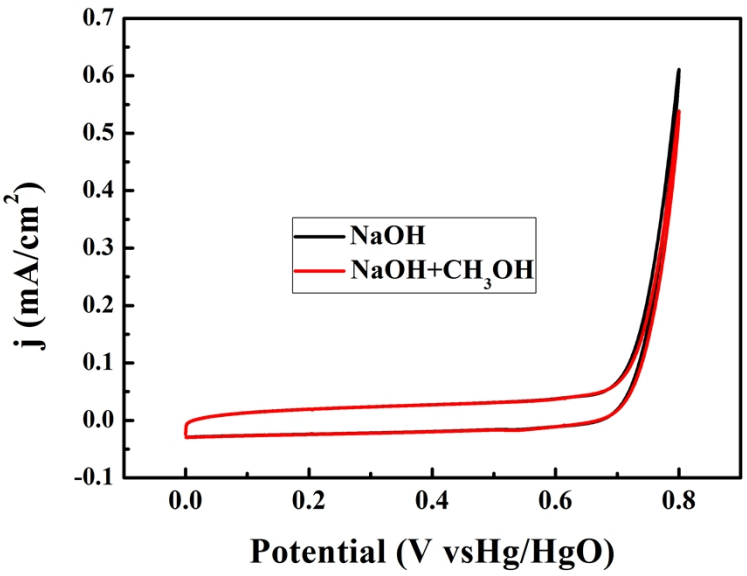

Figure S5. Cyclic voltammograms of Beta-SDS zeolite modified electrode in 0.1 M NaOH and in a mixture of 0.1 M NaOH and 0.1 M CH_3OH at scan rate of 50 mV/s.

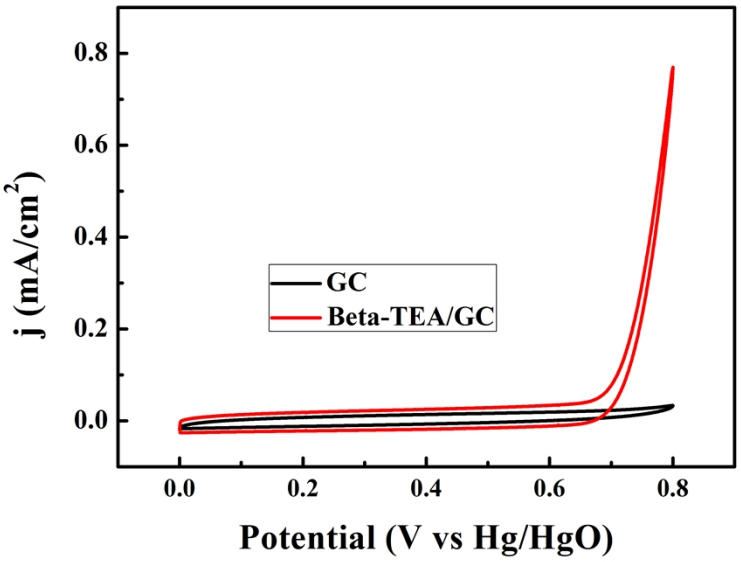

Figure S6. Cyclic voltammograms of glass carbon electrode (GC, black line) and Beta-TEA zeolite modified electrode (red line) in 0.1 M NaOH at scan rate of 50 mV/s.

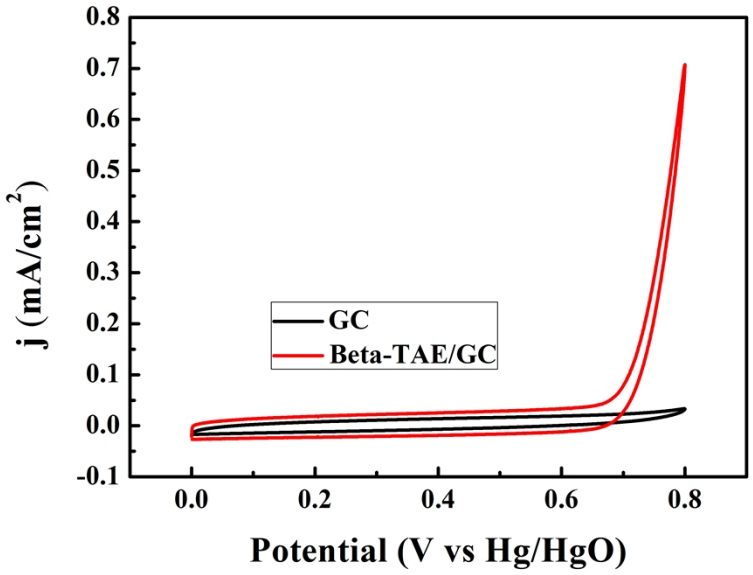

Figure S7. Cyclic voltammograms of glass carbon electrode (GC, black line) and Beta-TEA zeolite modified electrode (red line) in a mixture of 0.1 M NaOH and 0.1 M CH_3OH at scan rate of 50 mV/s.

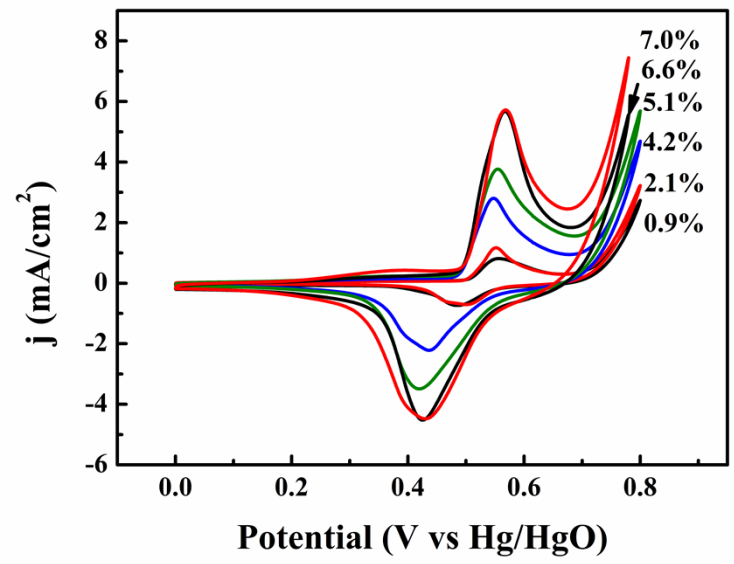

Figure S8. Cyclic voltammograms of Ni-Beta-SDS/GC electrocatalysts with various loadings of Ni^{2+} species in 0.1 M NaOH at scan rate of 50 mV/s.

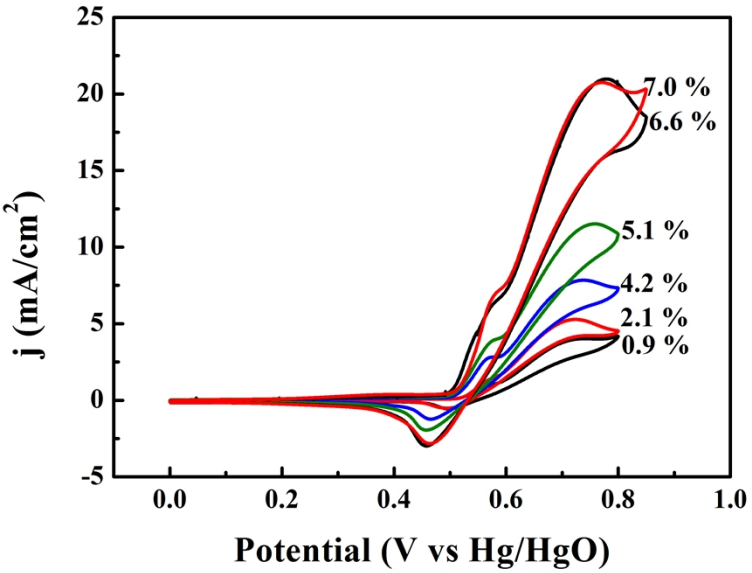

Figure S9. Cyclic voltammograms of Ni-Beta-SDS/GC electrocatalysts with various loadings of Ni^{2+} species in a mixture of 0.1 M NaOH and 0.1 M CH_3OH at scan rate of 50 mV/s.

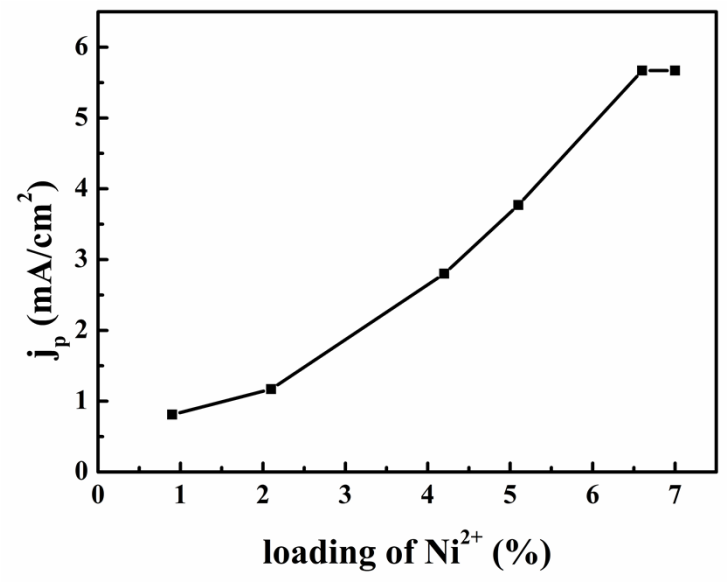

Figure S10. Dependence of current density in the oxidation peak on loading of Ni^{2+} species in the Ni-Beta-SDS/GC electrocatalysts in 0.1 M NaOH solution.

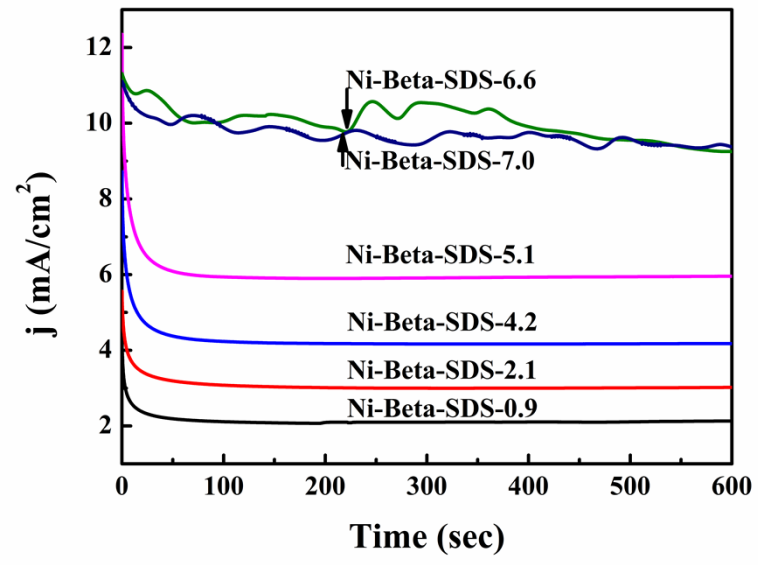

Figure S11. Chronoamperograms in methanol oxidation over Ni-Beta-SDS/GC electrocatalysts with various loadings of Ni^{2+} species in a mixture of 0.1 M NaOH and 0.1 M CH_3OH solutions at a potential step value of 0.7 V for 600 s.

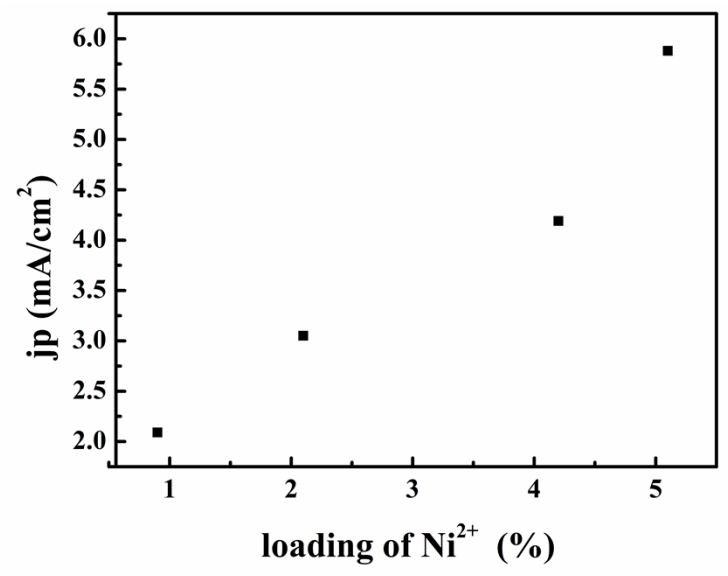

Figure S12. The stable current density in methanol oxidation over Ni-Beta-SDS/GC electrocatalysts with various loadings of Ni^{2+} species in a mixture of 0.1 M NaOH and 0.1 M CH_3OH solutions at a potential step value of 0.7 V for 600 s.

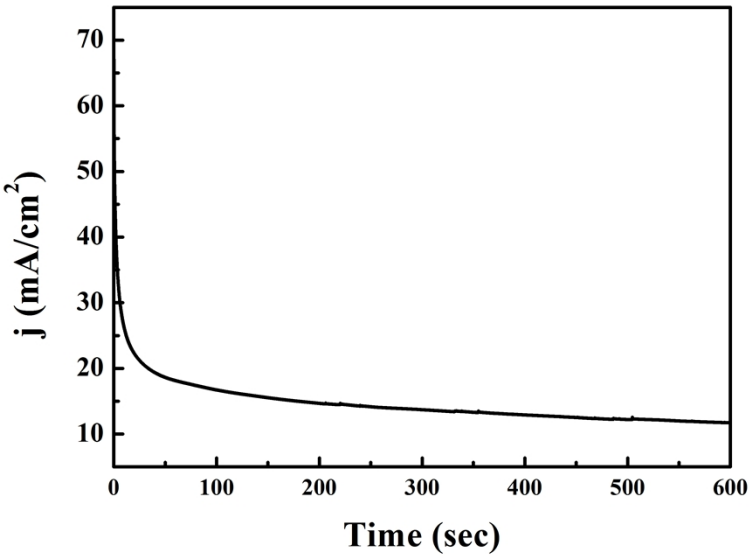

Figure S13. Chroanoamperogram in methanol oxidation over Pt/C electrode at 0.7 V in a mixture of 0.1 M NaOH and 0.1 M CH_3OH solution.

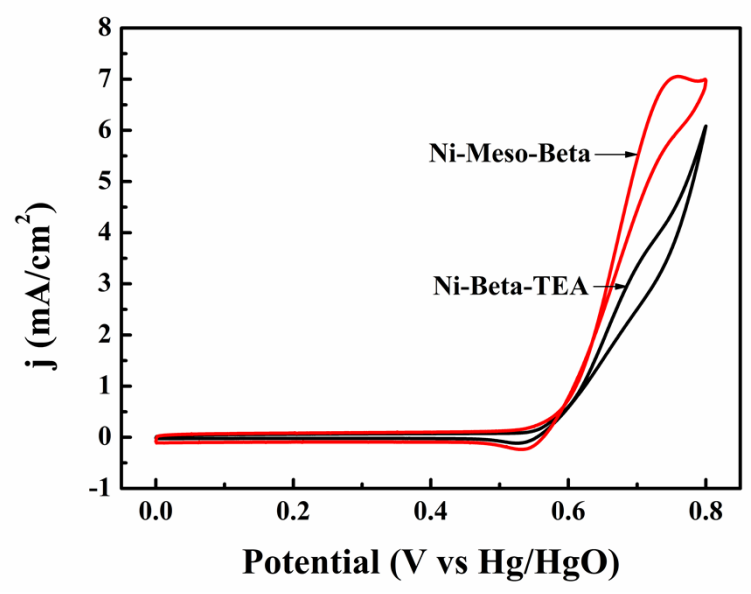

Figure S14. Cyclic voltammograms of Ni-Meso-Beta/GC (red line) and Ni-Beta-TEA (black line) electrocatalysts in the mixture of 0.1 M CH_3OH and 0.1 M NaOH at scan rate of 50 mV/s.