Experimental

The nickel oxide films were electrodeposited directly onto the stainless steel (SS) substrate by applying an anodic potential of 0.9 V versus a saturated Ag/AgCl electrode at room temperature. Prior to electrodeposition, SS foil was cut into pieces of 2 cm × 2 cm, which were then soaked in acetone and ultrasonically vibrated for 5 min to wash away any contaminants from their surface. De-ionized water was then used to rinse the SS foils in ultrasonic vibration for another 5 min. The plating solution was a mixture of 0.13 M sodium acetate, 0.13 M nickel sulfate, 0.1 M sodium sulfate, and 0.001 M surfactant (cetyltrimethylammonium bromide, CTAB). The anodic deposition of nickel oxide/hydroxide was carried out in a homemade three-compartment cell. A saturated Ag/AgCl electrode was used as the reference electrode and a platinum foil with dimension 2 cm × 2 cm was the counter electrode. All chemicals were analytical grade and were used without further purification. The plating solution was stirred by means of a Teflon stir bar on a magnetic plate at a rotational speed of 120 rpm during the deposition process. After deposition, the films were rinsed several times in ethanol to remove the surfactant, and then the films were annealed at 300°C for 1 h in air. The amount of deposited films was measured by a microbalance (Mettler, XS105DU) and was held approximately the same (about 0.5 mg) for each film by adjusting the deposition time.

The capacitive behavior of films was determined using cyclic voltammetry in a three-electrode cell with 1 M KOH electrolyte. The potential was cycled at various scan rates using a potentiostat (CH Instruments, CHI 608) in a potential range of 0-0.45 V. The galvanostatic charge and discharge were tested using a source meter (Keithley Instruments, model 2400) in a potential range of 0-0.45 V at 40 A g⁻¹. All data acquisitions from Keithley 2400 were carried out via a GPIB (General Purpose Interface Bus) card with LabVIEW software. Electrochemical impedance were performed by means of a potentiostat (CH Instruments, CHI 608) which was coupled to a frequency response analyzer under the open-circuit condition. An ac perturbation amplitude of 10 mV versus the open-circuit potential was applied in a frequency range from 50 kHz down to 0.1 Hz.
The surface morphology of the nickel oxide films was examined with a scanning electron microscope (SEM, JEOL JSM-6700F) with an accelerating voltage of 3 keV. The nanostructure of the porous nickel oxide films was examined with a transmission electron microscopy (FE-TEM, JEOL JEM-1400, Japan) with an accelerating voltage of 200 kV. TEM samples were prepared by the following procedure: the nickel oxide films after annealed at 300°C for 1 h were stripped off and dispersed in ethanol with ultrasonic vibration for 5 min, a drop of the supernatant was then transferred onto a standard holey carbon-covered-copper TEM grid. The crystal structure of nickel oxide films was identified by a glancing angle X-ray diffractometer (GAXRD, Rigaku D/MAX2500, Japan) with a Cu Kα target (wavelength = 1.54056 Å). Diffraction data were collected for 1 s at each 0.04° step width over 2θ, ranging from 10° to 90°.

**Surface morphology of nickel oxide films**

Figure S1 shows the SEM images of nickel oxide films grown on SS substrates with and without CTAB. Clearly, both deposited nickel oxide films are made up of flaky nickel oxide. The nickel oxide film deposited in the absence of CTAB possesses shallow pores in the film (Fig. S1a). As revealed in TEM image (Fig. 1a), beneath these shallow pores, the film may consist of very small pores, some of which may be closed. The existence of closed pores is an important drawback because the closed pores make it difficult for electrolyte to enter into the interior of film. Interestingly, the nickel oxide film deposited in the presence of CTAB is highly porous film with deep pores (Fig. S1b). As can be seen from TEM image (Fig. 1b), these deep pores are open macropores with a pore diameter of ca. 150-200 nm.

Both the adsorption of CTAB and electrodeposition of nickel oxide occur at the interface of the electrode. The interface between electrolyte and electrode is practically stationary. The thickness of the stationary layer can be significantly decreased by the forced convection under vigorous stirring. Some of the adsorbed CTAB molecules may be swept away from the electrode surface by the flowing electrolyte stream under the forced convection. The rotational speed of stir bar is very slow in this work (120 rpm), therefore it is reasonable that the influence of stirring on the growth of nickel oxide can be neglected. The main purpose of using stir bar is to maintain the homogeneity of bulk electrolyte.
Fig. S1   SEM images of the nickel oxide films deposited (a) without and (b) with CTAB.

X-ray diffraction

The crystal structure of nickel oxide films, which can be determined by a glance angle X-ray diffractometer (XRD), is affect by the annealing temperature and depositing parameters, consequently influences the capacitive behavior of films. Figure S2 shows the XRD patterns of nickel oxide films deposited with and without CTAB after annealing at 300°C for 1 h. The XRD result reveals that the diffraction patterns of nickel
oxide films resemble cubic NiO, regardless of the pore structure.

**Fig. S2** XRD diffraction patterns of the nickel oxide films.

**Cycle-life stability**

The cycle-life stability of nickel oxide films is carried out by galvanostatic charging/discharging at 40 A g\(^{-1}\) for 5000 cycles. Figure S3 shows the relationship between capacitance retention and cycle number of film deposited in the presence of CTAB. The capacitance retention of film increases slightly at the beginning of the 250 charging/discharging cycles, and then stabilizes for ongoing cycles. The decay rate in capacitance retention of film after 5000 cycles is small, reflecting a high durability of nickel oxide film for capacitor application in alkaline solution.
Fig. S3  Relationship between capacitance retention and cycle number of film deposited in the presence of CTAB.