electrochemically inert substrates such as mesoporous, high-surface-area SiO_2 aerogels (Ryan et al., *Nature* **406** (2000) 169–172; US Patent Nos. 6,290,880 and 6,649,091) or macroporous SiO_2 filter papers (Chervin et al., *Nano Lett.* **9** (2009) 2316–2321; US Patent Application Publication No. 2009/0092834) has been demonstrated. The RuO_2 nanoparticles form a ~2-nm-thick, through-connected network on substrates of high curvature (Ryan) or contiguous shell on substrates of low curvature, such as the >100-nm diameter fibers in silica-fiber paper (Chervin). In the latter, the resulting $RuO_2(SiO_2)$ paper contains ~300 $\mu g\ cm^{-2}$ of 2–3-nm RuO_2 nanoparticles that occupy only 0.1 vol% of the total object, yet the paper displays a geometry-normalized conductivity of ~0.5 $S\ cm^{-1}$ after heat treatment in air. The $RuO_2(SiO_2)$ paper also expresses large electrochemical capacitance (>600 $F\ g^{-1}$ as normalized to the mass of RuO_2) and high surface area of the conductive phase (~90 $m^2\ g^{-1}$) indicating that a majority of the deposited RuO_2 is connected within the electronic circuit and electrochemically addressable, thereby optimizing utilization of this expensive component.

SUMMARY

In a first aspect, there is provided an article comprising: a substrate; and a RuO_2 coating on a portion of the substrate; wherein the coating comprises nanoparticles of RuO_2, and the coating comprises at least 90% RuO_2.

In a second aspect, there is provided an article comprising: a substrate; and a RuO_2 coating on a portion of the substrate; wherein the coating comprises at least 90% RuO_2, and wherein the coating is made by a method comprising: immersing the substrate in a solution of RuO_4 and a nonpolar solvent at a temperature that is below the temperature at which RuO_4 decomposes to RuO_2 in the nonpolar solvent in the presence of the substrate; and warming the substrate and solution to ambient temperature under ambient conditions to cause the formation of the coating.

DISCLOSURE OF THE INVENTION

Disclosed herein is an article comprising: a substrate; and a RuO_2 coating on a portion of the substrate. The coating comprises nanoparticles of RuO_2.

Also disclosed herein is an article comprising: a substrate; and a RuO_2 coating on a portion of the substrate. The coating is made by a method comprising: immersing the substrate in a solution of RuO_4 and a nonpolar solvent at a temperature that is below the temperature at which RuO_4 decomposes to RuO_2 in the nonpolar solvent in the presence of the substrate; and warming the substrate and solution to ambient temperature under ambient conditions to cause the

formation of the coating.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention will be readily obtained by reference to the following Description of the Example Embodiments and the accompanying drawings.

Fig. 1 shows electron micrographs of 2–3-nm-thick films of RuO_2 deposited on planar CaF_2 (top) and Si (bottom). The coatings were heated to 200°C in air after deposition.

Fig. 2 shows extinction (equal to log (1/T)), where T is transmitted intensity, $T = I/I_o$) spectra for a single 2–3-nm-thick film of RuO_2 on a planar CaF_2 substrate. The solid line is the coated substrate (with the CaF_2 extinction subtracted) and the dashed line is an uncoated CaF_2 sample.

Fig. 3 shows extinction spectra in the UV to near-infrared regions for 1, 2 and 3 layers