NANO3D SYSTEMS LLC 1110 NE Circle Blvd., ATAMI/Bldg. 11, Corvallis, OR 97330
T 503-927-4766| F 541-758-9320| https://nano3dsystems.com

Metal Oxides (MO^{2-})

Properties

Metal oxides typically contain an anion of oxygen in the oxidation state of −2. Noble metals (Au, Pt et al) are prized because they resist direct chemical combination with oxygen. The wide range of properties are exhibited by metal oxides such as metallic (ITO, RuO_2, ReO_3, $LaNiO_3$ et al), semiconducting (Cu_2O et al) and insulating (TiO_2, MnO_2, Al_2O_3, $BaTiO_3$ et al) properties. Magnetic properties range from ferromagnetism (CrO_2, $La_{0.5}Sr_{0.5}MnO_3$ et al) to antiferromagnetism (NiO, $LaCrO_3$ et al). Many oxides possess switchable orientation states as in ferroelectric (BaTiO3, KNbO3 et al) and ferroelastic ($Gd_2(MoO_4)_3$ et al). High-temperature superconductivity exists in cuprates.

Plating Solutions

In the electrodeposition of metal oxides, several methods can be used [1-5, 9, 10], including a) cathodic deposition of metal hydroxides/oxides (β-$Co(OH)_2$, δ-Bi_2O_3, Cu_2O, ZnO, Fe_3O_4, CuO, $CoFe_2O$, Mn_3O_4, Co_3O_4, PbO_2/Tl_2O, $Fe_3O_4/ZnFe_2O_4$ et al) from alkaline solutions containing alkalis (NaOH, KOH), nitrates (the hydroxyl ions are generated by reduction of nitrate ions) or chlorides (base is generated in the presence of zinc ions), b) anodic deposition of metal oxides facilitated by oxygen generated on the anode, c) amphoteric metal oxides such as ZnO, Al_2O_3, SnO_2, SnO, Co_3O_4, PbO_2, PbO and Cr_2O_3 can be deposited by electrochemically changing local pH, d) tungstic and other oxides can be also electrodeposited by using acidic precursors (such as peroxotungstic et al) as electrolyte solutions. For example, β-$Co(OH)_2$ can be deposited by electrochemically reducing tris(ethylenediamine)cobalt(II) in alkaline solution and vanadium pentoxide coatings can be electrodeposited at room temperature in alkaline solution of methanol and vanadyl (III) acetyl acetonate.

Applications

Transition metal oxides are commonly utilized for their catalytic activity and electronic properties. Transition metal oxides are also frequently used as pigments in paints and plastics. Cuprous oxide (Cu_2O) is a nontoxic and inexpensive semiconductor material with a direct band gap of 1.8eV [6]. Transition metal oxides, hydroxides (MnO_2, Co_3O_4, MoO_3, $Ni(OH)_2$, etc) have high capacitance. For example, MnO_2 exhibits capacitance exceeding 200 F/g in solutions of several alkali salts, such as LiCl, NaCl, and KCl [7]. Among the transition metal oxides, vanadium pentoxide (V_2O_5) is an excellent candidate for redox-dependent applications such as cathodes for lithium-ion batteries [8]. Cobalt hydroxide, β-$Co(OH)_2$ is a promising material for energy conversion and storage. It is a common additive in Ni-based rechargeable alkaline batteries. $Co(OH)_2$ is known as an earth abundant catalyst for the oxygen reduction and hydrogen evolution reactions. ZnO has several favorable properties such as good transparency in the visible and high infrared spectrum, high electron mobility, wide and the direct band gap, large exciton binding energy, high thermal conductivity and strong room temperature luminescence. These properties are used in many applications such as transparent electrodes of thin film solar cells for light transmission and the extraction of photocurrent, heat-protecting windows, transparent oxide thin-film transistors, light-emitting diodes, varistors, piezoelectric devices, etc [9].

References:

1. R. Subbaraman et al. Nat. Mater. **11**, 550, 2012.
2. V. Pralong et al. *J. Electrochem. Soc.* **147**(4), 1306-1313, 2000.
3. J.A. Koza, C.M. Hull, Y.-C. Liu, and J.A. Switzer. *Solution. Chem. Mater.* **25**, 1922-1926, 2013.
4. J.R.S. Brownson and C. Levy-Clement, C. *Electrochim. Acta* **54**, 6637-6644, 2009.
5. J.A. Switzer, M.G. Shumsky, and E.W. Bohannan. *Science* **284**, 293-296, 1999.
6. X. Han, K. Han, and M.Tao. *This Solid Films* **518**, 5363-5367.
7. M. Fahoumea et al. *Solar Energy Materials & Solar Cells* 9**0**, 1437-1444, 2006.
8. S. Gupta, B. Aberg, S.B. Carrizosa, and N. Dimakis. *Materials* **9**, 615, 2016.
9. M. Kumar and C. Sasikumar. *American Journal of Materials Science and Engineering* **2** (2), 18-23, 2014.
10. W.L. Kwong et al. *Energy Procedia* **34**, 617-626, 2013.

CONTACT NANO3D SYSTEMS LLC TO FORMULATE METAL OXIDES PLATING SOLUTION PER YOUR REQUIREMENTS