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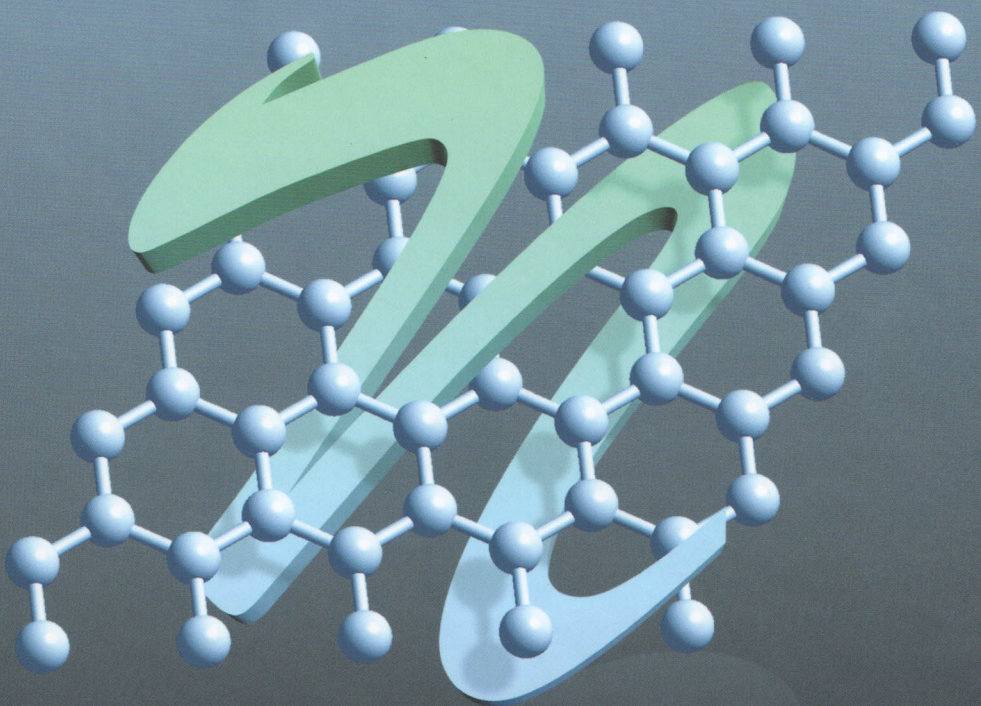

PROCEEDINGS OF INTERNATIONAL CONFERENCE
NANOMEETING – 2011

REVIEWS AND SHORT NOTES

PHYSICS, CHEMISTRY AND APPLICATIONS OF NANOSTRUCTURES

More specifically, in the case of the MIM capacitors, we have demonstrated that the PAA devices satisfy both the capacitance and leakage current density ITRS requirements. In the case of the coefficient α, our results are comparable to most reports. These devices are therefore very promising for a use in RF circuits.

For the MOS memory structures, we have shown that they can be fabricated using a single anodization step for the dielectric stack. There exists the memory window of 9 V for 1 s pulses and 1 V for 1 ms pulses. The retention of these devices (~1 V after 10 years) is as good as devices with complicated dielectric stacks instead of the single dielectric layer used in this work.

Acknowledgments

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NANOSIZED METAL AND ANODIC OXIDE FILMS WITH IMPROVED OPTICAL FEATURES FOR DISPLAYS AND PHOTONIC DEVICES

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A technique for fabrication of nanosized metal and anodic oxide films with improved optical features for displays and photonic devices is discussed. We have found that for dielectric substrates like glasses the special method of current control should be applied during anodizing a metal film. This method can change the porous oxide structure at the final stage and prevent formation of metal islands. To transform the residual metal into oxide, special fading process similar to anode bonding can be used.

1. Introduction

Electrochemical technologies have high potential in production of displays and optoelectronic devices because of cheapness and simplicity, low temperature of procedures and easy of scaling up to large substrates [1]. Both displays and optoelectronic devices include transparent media, therefore the anodizing technologies for Al, Ti and W foils and thin films are of special practical interest. Some anodic nanosized oxides like TiO_2 or WO_3 have semiconductor properties which can be effectively used in displays and photovoltaic applications. However, processes of their formation through anodizing over ITO layers are not enough investigated to date. The primary goal the present work is to develop the fabrication technique of nanosized metal and anodic oxide films with improved optical features for displays and photonic devices.

2. Anodizing of metal films and foils on substrates

A bonding of bulk anodic metal to a glass is well known [2] and provides excellent adhesion and vacuum sealing quality. However, a glass with corresponding thermal expansion should be used in this technique. For example, correspond glasses for Al do not exist, and for Ti and W they provide the ionic conductivity only at elevated temperatures. It is possible to use a metal-glass system with significant difference in thermal expansion in the case of a metal foil with high elasticity [3]. Sodium glass and aluminum foil is an example [4]. For Ti or W foils a special surface treatment is needed. A foil should be polished to provide the best adhesion. However, polishing is not enough to achieve well

organized honeycomb structure of anodic oxide (Fig. 1). Thermal annealing of the foil is more important for the best pore organizing.

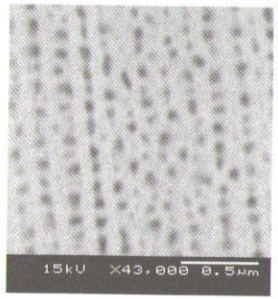

Figure 1. Anodized polished Al foil.

We have experimentally found that the optimal conditions for aluminum foil-sodium glass bonding process are: bonding duration is about 10 min, bonding temperature is 270-300 °C, current density is ~5 mA/cm^2 at negative bias at high voltage electrode in the range of 1200-1600 V.

While anodizing a metal foil, many metal islands remain at the interface between the insulator substrate and the anodic oxide due to local inhomogeneities of the foil thickness and anodizing current. If an island was created, the anodizing process is stopped on it because of the current interruption. To overcome this problem, we have developed the special current control method which changes the oxide porous structure on the final stage of the anodization process and prevents the metal islands formation.

The additional factor which downs the transparency of oxide films is an appearance of vertical metal nanowires [5]. To transform these nanowires to oxide, the special fading process similar to anoding bonding can be used [6]. Nanoporous oxides usually have much lower refractive indexes than any bulk material and can be used as effective antireflective layers. TiO_2 films can form the "self cleaning" surface due its semiconductor photonic properties and oxygen producing. This process can be used to fabricate functional layers for optoelectronic devices by filling the pores with different species [7].

3. Fabrication of transparent conductive aluminum nanomesh

In design of displays and some photonic devices an oxide film is to be placed on a transparent conductive substrate, usually ITO on a glass. However, high concentrated electrolytes used for the anodizing process can destroy ITO layers. To solve this problem we have found suitable reagents and compositions.

In a nanomesh film the transparent and conductive functions are separated in space, but a nanomesh pitch has the subwavelength size. A usage of nanomesh films allows overcoming some fundamental limitations inherent for conductive oxides.

The geometrical structure of a nanomesh film and the theoretical results (resistance and transmittance for different pitch values) are presented in Fig. 2.

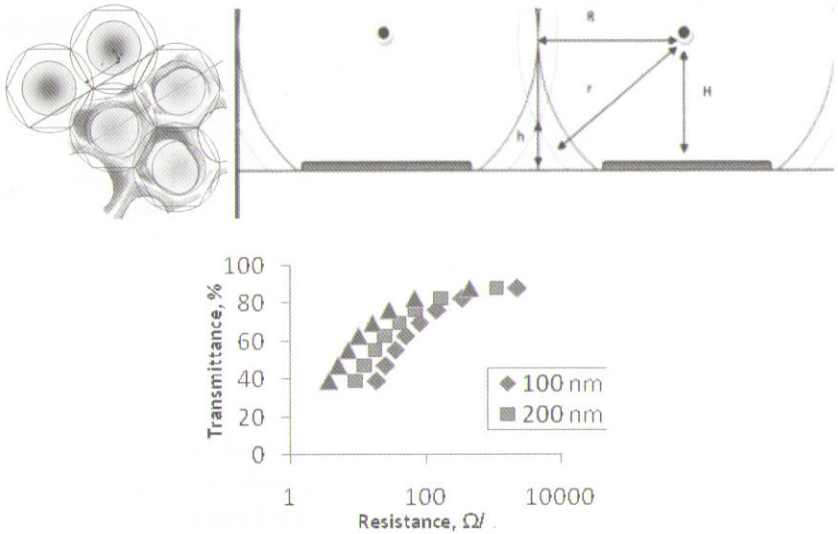

Figure 2. Geometrical structure and calculation results for a nanomesh.

We have fabricated the transparent conductive aluminum nanomesh layers on glass and plastic flexible substrates through the simple anodizing process. The anodizing parameters were changed at the final stage [8]. This method allowed to open transparent windows and leave a nanomesh from the rest of aluminum. Scanning electron microscopy (SEM) image of Al nanomesh after selectively etching of Al_2O_3 skeleton is presented in Fig. 3.

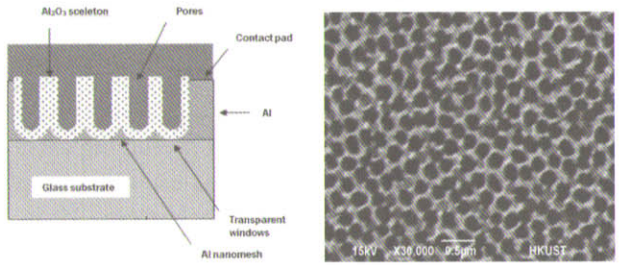

Figure 3. Structure of the transparent conductive nanomesh and its SEM image.

4. Conclusion

We have considered the techniques of anodized metal film fabrication on dielectric substrates and demonstrated the new approach to produce transparent conductive aluminum nanomeshes.

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GENERATION OF MICROPLASMA FROM NANOPORES OF ZEOLITE IN SEMICONDUCTOR GAS DISCHARGE ELECTRONIC DEVICES

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A zeolite plate with push contacts was placed in a chamber filled with air at a controllable pressure. The current–voltage characteristics of the zeolite plate were measured as a function of the air pressure in the chamber. It is found that the gas in zeolite pores is ionized and, accordingly, the number of electrons in the pores grows. Such plate used as a cathode in a planar gas discharge cell considerably reduces the breakdown voltage of the gas discharge.

1. Introduction

High emissive characteristics of nanotubes and pores provide the basis for a new class of electron emitters with extremely low voltage and power consumption [1,2]. The unique emissive properties of carbon nanotubes (CNTs) render them effective electrode coatings in discharge devices. Field-emission-cathode gas discharge luminescent lamps are widely used for the background illumination of LCD screens. A new design of a cathode for luminescent lamps in which CNTs are applied to decrease the working voltage was suggested in [3]. The addition of CNTs to the electrodes also sharply decreases the discharge-maintaining voltage (from 670 to 87 V). Shikhaliev [4] proposed a model of field-enhanced self-sustained electron emission in porous dielectrics implemented in IR imaging devices [5–7]. In these works, the electron emission from pores and CNTs is attributed either to the effect of field enhancement near the top of the CNT or to the avalanche multiplication of charge carriers due to the impact ionization of the CNT walls. Another view of the mechanism underlying the electron emission from pores was put forward by Tatarinova [8,9], who observed a current in the vacuum gap that was emitted from the cathode with a porous surface and from getters. The current–voltage characteristic (CVCs) was linear, and the current depended on the gas saturation of the getters and pores on the cathode surface. It was hypothesized that the resonance desorption of the gas in the presence of water O_2, or N_2 molecules is the only physical phenomenon that can be responsible for the emission. Negative ions recombine on the surface of pores, liberating electrons, the energy of which (few eV) suffices to maintain the