NEW HOT PAPERS - 2009

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Patrik Schmuki talks with *ScienceWatch.com* and answers a few questions about this month's New Hot Paper in the field of Materials Science. The author has also sent along images of their work.

Article Title: TiO2 nanotubes: Self-organized electrochemical formation, properties and applications
Authors: Macak, JM;Tsuchiya, H;Ghicov, A;Yasuda, K;Hahn, R;Bauer, S; Schmuki, P
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SW: Why do you think your paper is highly cited?

TiO_2 nanotubes can be produced by a simple electrochemical method which is based on a natural self-organizing process. TiO_2, as such, is a highly interesting functional material, and the possibility to produce highly controlled nanostructured surface layers of this material enhances and enables the tailoring of many of the properties.

Moreover, not only the geometrical factors of the nanotube layers (e.g., length and diameter of the tubes) but also the crystal structure or chemistry of the tubes can be modified by special treatments.

Therefore, as TiO_2 nanotubes have such a broad range of potential applications—solar cells, biomedical, photocatalytic—the findings we reported were quickly picked up by the research community.

SW: Does it describe a new discovery, methodology, or synthesis of knowledge?

It reviews some of the latest findings and provides new and unique concepts on growth mechanisms.

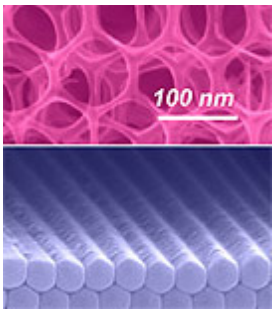
SW: Would you summarize the significance of your paper in layman's terms?

Several experimental findings are pulled together and unified in easy to understand concepts—experimentally, the key factors on how to grow "nice" self-organized TiO_2 nanotube layers are provided, but also the phenomenon is explained to a level that seems plausible not only to

us, but to others as well.

The paper also highlights possible improvements of different important technologies such as solar cells or biomedical implants by such nanostructured surfaces.

Moreover, an exciting part of the work is the fact that these highly ordered nanotubular surface layers with a plethora of functional properties can be prepared by a relatively simple and cheap electrochemical approach. Merely apply some voltage to a titanium metal sheet immersed in the right solution and, after some time, the entire surface will be covered with vertically aligned titaniumdioxide nanotubes.



Anodically formed self-organized TiO2 structures. Top: nanolace, bottom: self-aligned TiO2 nanotubes.

SW: How did you become involved in this research, and were there any problems along the way?

After a more or less coincidental finding, we followed up on the electrochemical formation of self-organized TiO_2 nanotubes for several years and improved aspect ratio, tube-wall morphology, and long-range ordering. Also, approaches to modify the nanotube properties (e.g., doping, crystal structure, filling of the tubes, etc.) were explored to pave the way for possible applications.

Two key findings were the essential role of the control of pH-gradient within the tubes and the influence of non-aqueous electrolytes for the process of nanotube growth. To conceptually realize this and experimentally establish the optimum conditions took hard work and the dedicated efforts of several Ph. D. students.

SW: Where do you see your research leading in the future?

Further control over the nanotube shape, control over diameter, structure etc., will allow the field of applications to increase. Currently, biomedical applications (biocompatible coating, drug delivery) seem very promising and we are dedicating a lot of effort toward this direction.

SW: Do you foresee any social or political implications for your research?

Indeed, in the long run, the basis of new biotolerant/or rejecting surfaces may be provided.

And also, in the field of energy production or highly defined catalysis applications several new concepts seem feasible.

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KEYWORDS: SELF-ORGANIZATION; TITANIUM DIOXIDE; ELECTROCHEMICAL ANODIZATION; NANOTUBES .

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