MIET National Research University of Electronic Technology

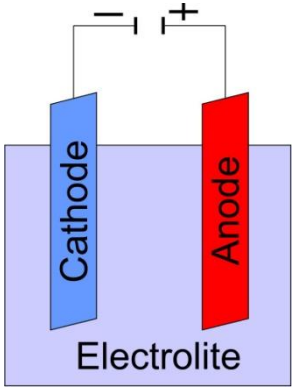
6th International School-Conference on Catalysis for Young Scientists

Photocatalytic and photoelectrochemical properties of carbon modified anodic TiO_2 nanotube arrays

Savchuk Timofei

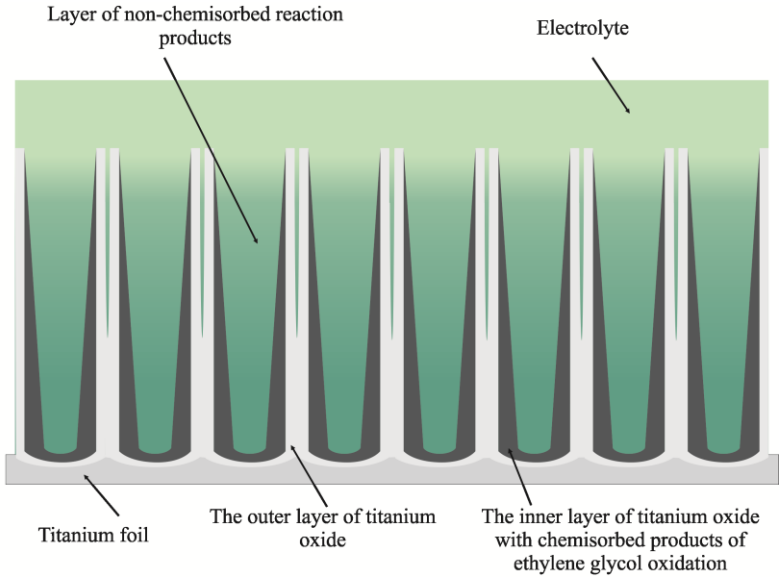
Anodic TiO_2 nanotube arrays

Preparation method:
Electrochemical anodization



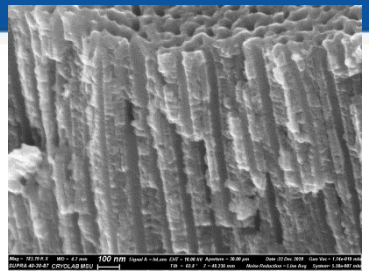
Anodization conditions:
Electrolyte:
Ethylene Glycol + 0,3 NH_4F + 2 ml H_2O on 100 ml
Temperature: 20 °C
Potentiostatic 60 V 1h

Scheme of amorphous anodic TiO_2 nanotube arrays forming in ethylene glycol based electrolyte

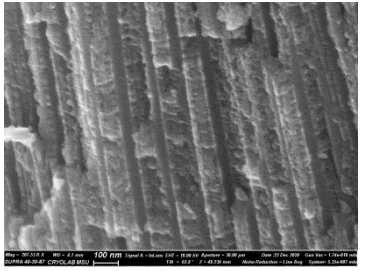


Cross-section view of annealed nanotubes

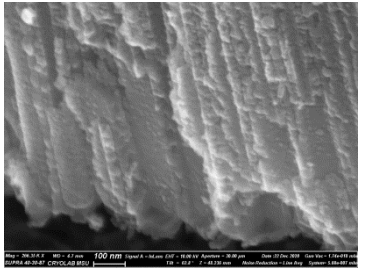
Top



Middle

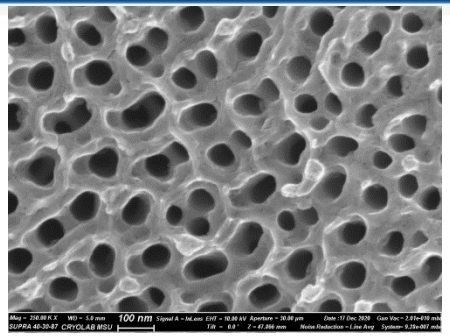


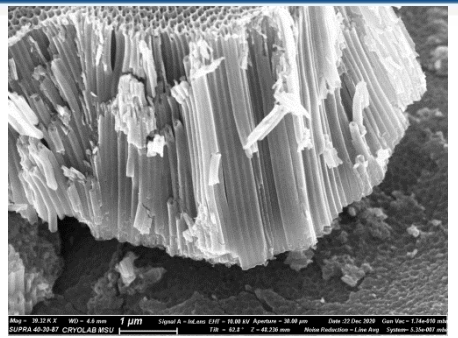
Bottom



Scope and modification method

Top and full cross-section view





Modification method:

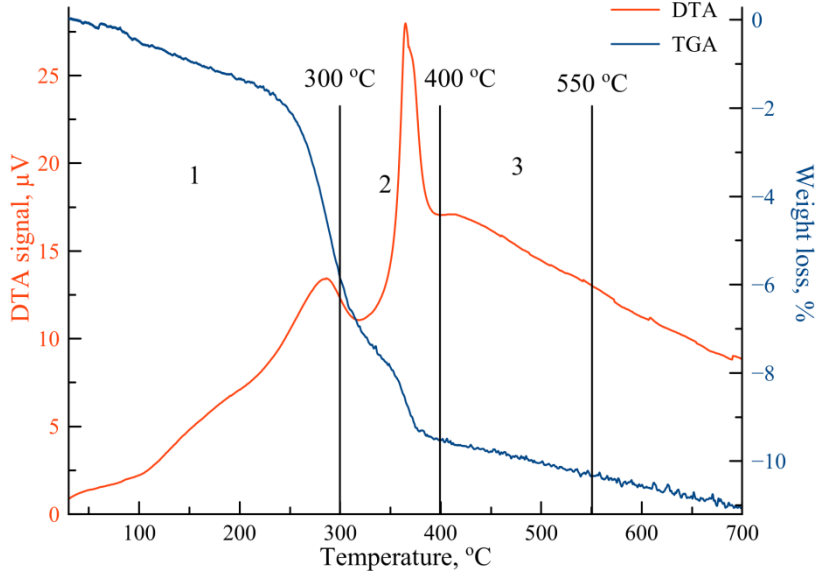
Carbon modification of anodic TiO_2 nanotubes was realize by thermal treatment in inert atmosphere (argon) of as-prepared samples. The inner layer of nanotube riched by organic products used as source of carbon.

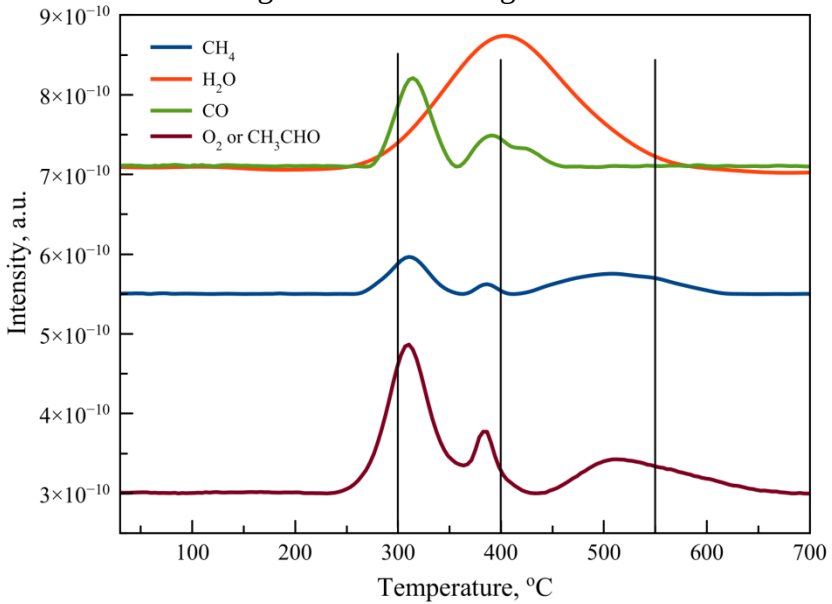
Scope:

In this work we investigate how temperature of annealing in argon influenced on composition, structure, photoelectrochemical and photocatalytic properties of anodic TiO_2 nanotube arrays formed in ethylene glycol based electrolyte.

Choosing of key temperature points

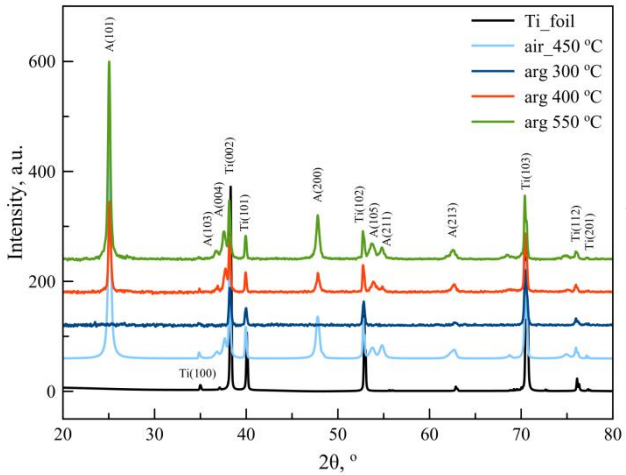
Areas: 1 – before crystallization; 2- during crystallization; 3 – after crystallization and maximum of carbon species are removed.
300, 400, 550 °C temperatures were chosen. Pyrolysis of organic species is observed during all time of heating.

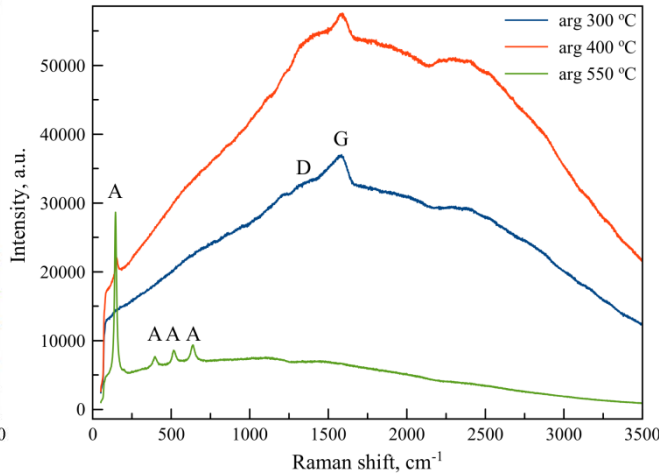


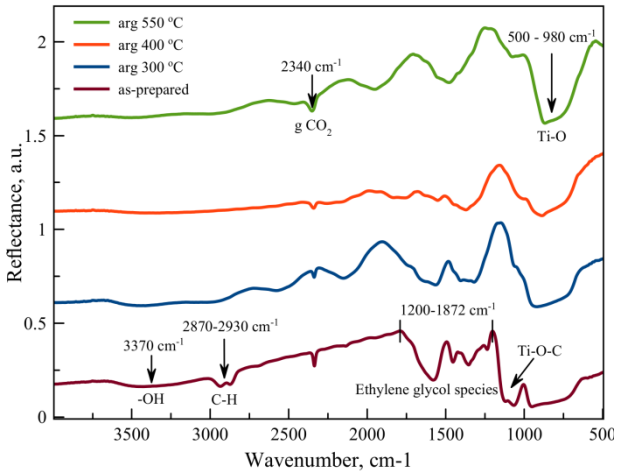


In-situ mass-spectra during on thermal heating (10 °C/min) of as-prepared TiO_2 nanotube arrays and DT, TG analysis in argon flow (10 cm^3/min)

Structure and composition



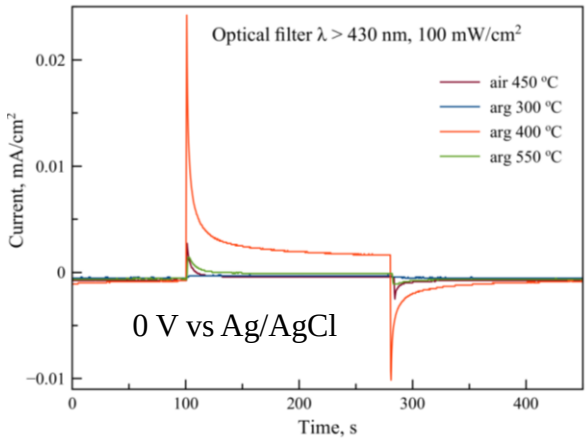


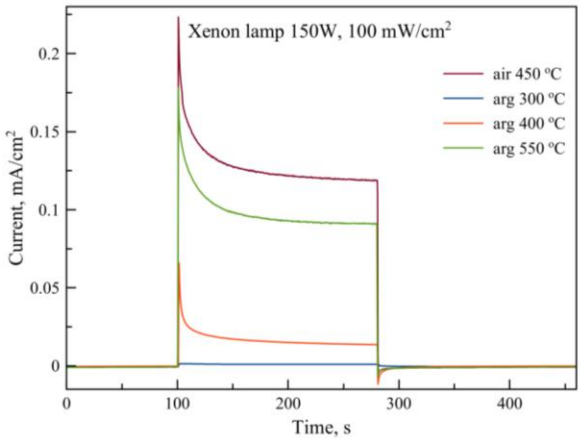


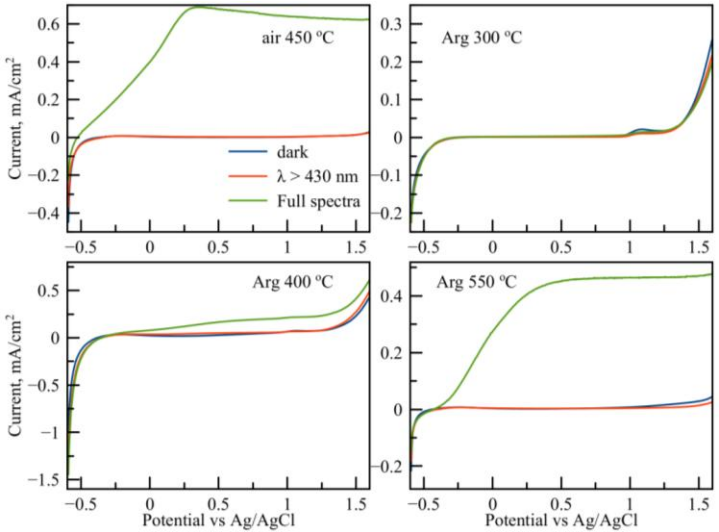
FT-IR

as-prepared – presents of ethylene glycol species;
air 450 °C – reference sample, crystallized;
Arg 300 °C – non crystallized, carbon presents is observed;
Arg 400 °C – crystallized, carbon presents is observed;
Arg 550 °C – crystallized, carbon presents is not observed by used methods.

Photoelectrochemical properties

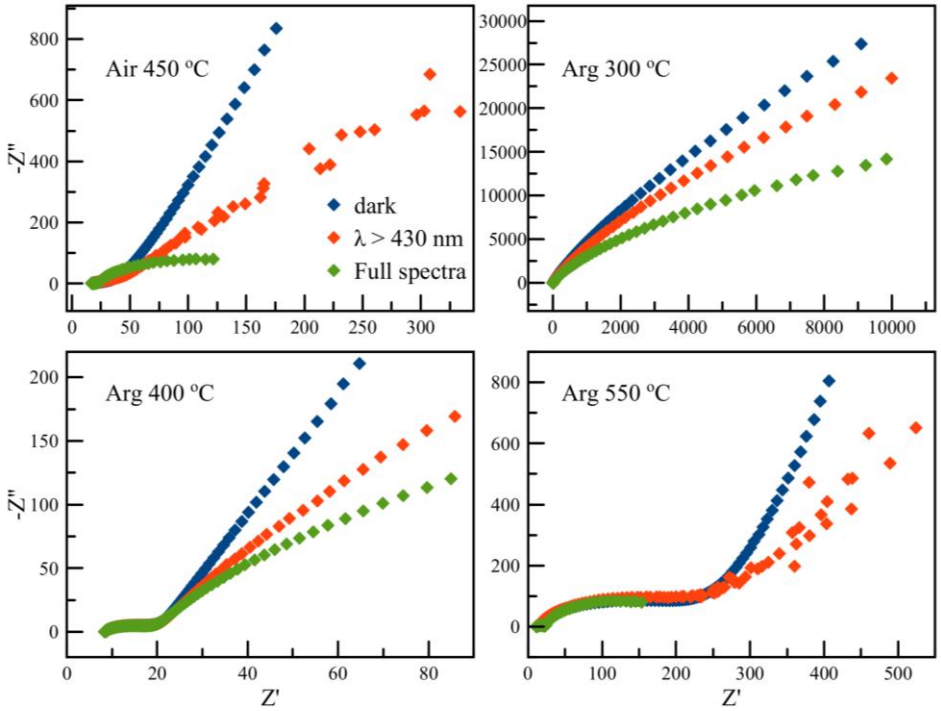


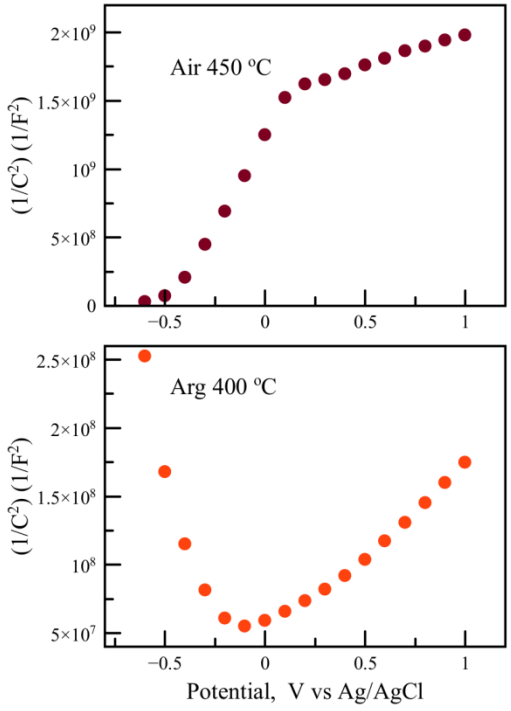


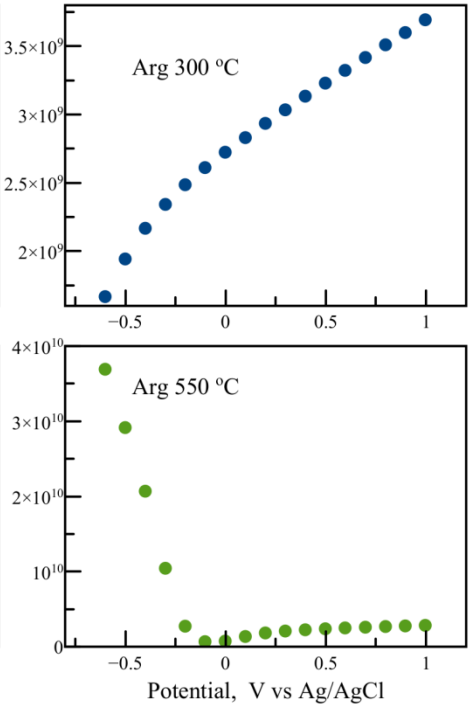


Air 450 °C - low activity in visible light region, highest activity in full spectra (UV+Vis);
300 °C – lowest photoelectrochemical activity;
400 °C – highest activity in visible light region compared with other samples, low activity in full spectra (UV+Vis);
550 °C – low activity in visible light region, highest activity in full spectra compared with annealed samples in argon atmosphere.

Photoelectrochemical properties







FRA Potential Scan measurements were obtained under UV-Vis light irradiation (Frequency 1000 Hz), amp 10 mV.

Photocatalytic degradation of methylene blue under visible light and Results

Conclusions:

Reference sample annealed in air at 450 °C non active in visible region. Carbon species is observed in samples annealed in argon. Sample annealed in argon at 300 °C (Arg 300) non active in visible region, concentration change of MB in the dark is not observed. Dark concentration change is observed only on crystallized samples annealed in argon. Highest activity in visible light region compared with other samples is observe for sample “arg 400". Moreover, for arg 400 observed high rate of dark MB concentration change, that could be related to presents of carbon species. Increase of annealing temperature lead to remove of carbon and decrease of dark concentration change rate. Concentration change under visible light for all samples comparable with self degradation. The photoelectrochemical activity under visible light irradiation of investigated samples can be represented as follows: arg 400>arg 550>air 450>arg 300, under uv-vis irradiation air 450>arg 550>arg 400>arg 300.