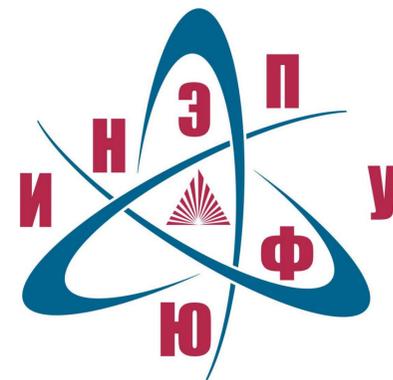




Investigation of the structure of manganese-doped silicon-carbon films obtained by electrochemical method



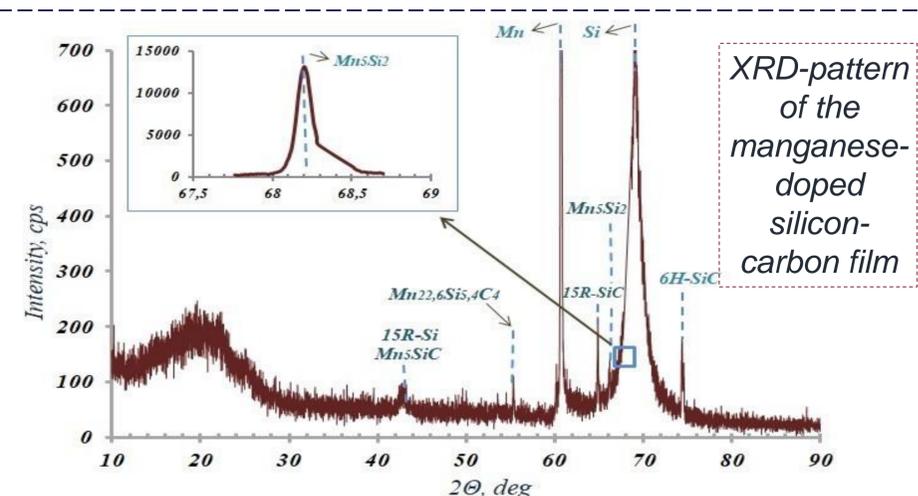
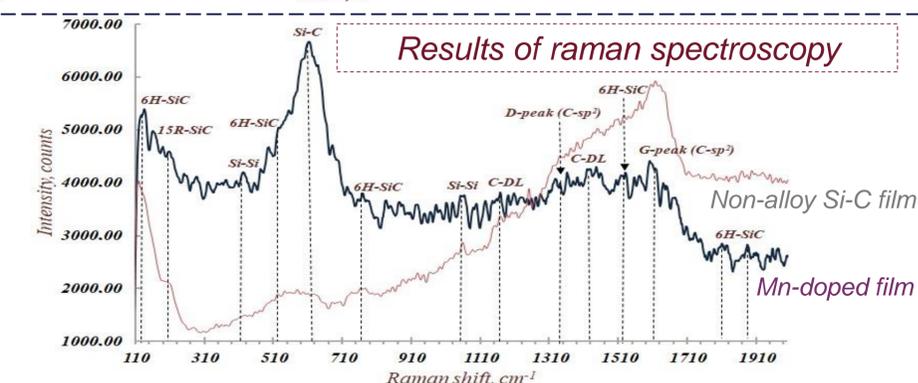
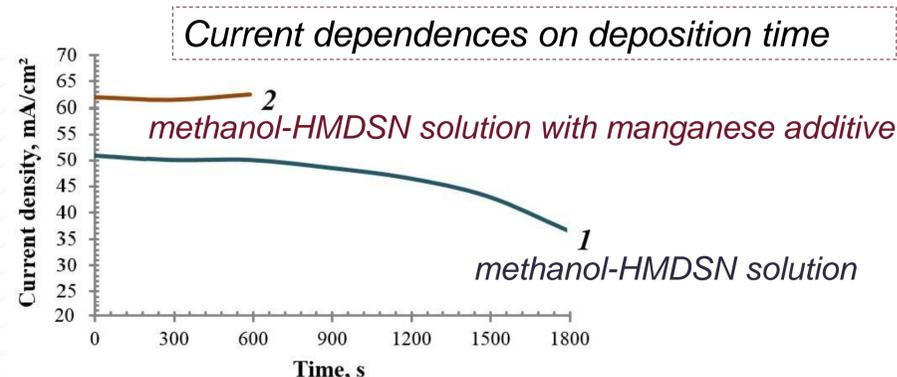
T.S. Mikhailova¹, M.N. Grigoryev², T.N. Myasoedova¹

¹ Institute of Nanotechnologies, Microelectronics and Equipment Engineering, Southern Federal University, Taganrog 347900, Russia

² JSC "Taganrog Scientific-Research Institute of Communication", Taganrog 347913, Russia

Manganese-doped silicon - carbon films were obtained on a substrate by using the electrochemical deposition at room temperature and atmospheric pressure from the methanol, hexamethyldisilazane and manganese sulfate (CH_3OH , $(\text{CH}_3)_3\text{-Si-NH-Si-(CH}_3)_3$ (HMDSN), $\text{MnSO}_4 \cdot 5\text{H}_2\text{O}$) solution. The analysis derived from the X-ray diffraction pattern indicates that Mn atoms react with Si atoms and then form mainly Mn_5Si_2 and $\text{Mn}_{22,6}\text{Si}_{5,4}\text{C}_4$ compounds.

- Silicon-carbon films have a set of properties that make it possible to use them in microelectronics.
- Chemical modification with metals makes possible to additionally provide new properties of the films and allows their use in supercapacitors.
- Manganese compounds, due to their high specific capacity, availability, and environmental safety are of the greatest interest as active electrode materials for electrochemical supercapacitors, is a promising ferromagnetic material.



Mn as an impurity element disturbs the phase equilibrium and induces the formation of Mn_5Si_2 and $\text{Mn}_{22,6}\text{Si}_{5,4}\text{C}_4$ phases. $\text{Mn}_{22,6}\text{Si}_{5,4}\text{C}_4$ is a good electronic conductor.

Thus, Mn-doped silicon-carbon films can be obtained from methanol-HMDSN-manganese sulfate solutions by the two-stage electrochemical deposition.

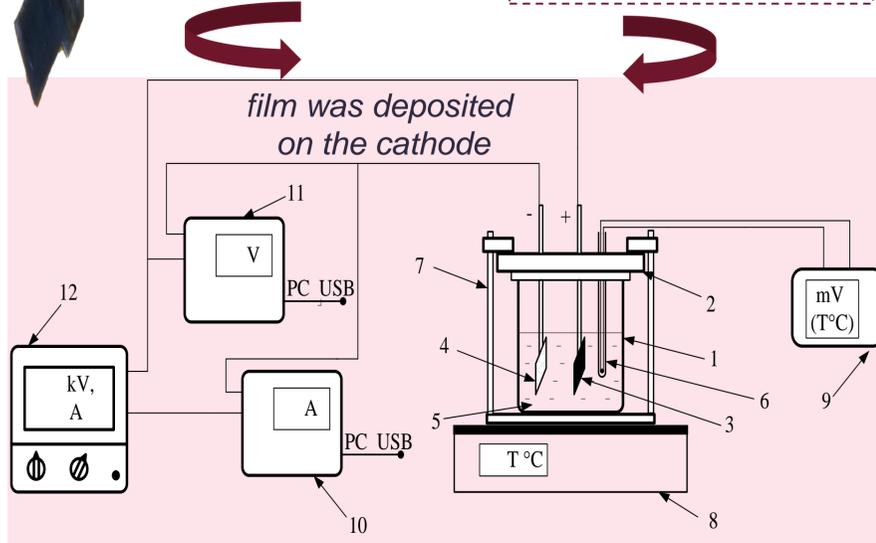
The work was supported in part by the Ministry of Science and Education Russia, under Contract №14.575.21.0126 (unique identifier of the contract is RFMEFI57517X0126)

Substrate treatment in the H_2SO_4 solution for a few minutes

Experimental Experimental

I stage Precipitation of a silicon-carbon film from a solution of methanol with HMDSN (ratio 9:1) for about 8 hours

II stage Precipitation of a Mn-doped film from this solution with manganese sulfate (0,05 %) for about 10 minutes



Schematic structure of electrolytic deposition system

- 1 - glass cell, 2 - dielectric cover, 3 - graphite anode, 4 - cathode-substrate, 5 - solution, 6 - thermocouple, 7 - clamps, 8 - thermal table, 9 - voltmeter of thermocouple, 10 - ammeter, 11 - HV-voltmeter, 12 - power supply