NEW TECHNOLOGY FOR FUNDAMENTAL STUDY OF THE PHYSICAL PROPERTIES OF METAL-OXIDE SINGLE NANOWIRES AND NANOPARTICLES USING MICROSCOPY AND NANOTOOLS BASED ON SHAPE MEMORY ALLOYS

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The rapid development of nanotechnology last time induced wide investigations of nanoscale materials, including nano-particles, and, in particular, 1D-structures like nanotubes, nanowires (NWs), etc of various materials. Past decade these nanoscale materials were intensively studies and they had appeared to have unique properties allowed to construct separate nano-device from individual nano-objects [1-7]. Many single nano-devices were developed from individual CNT [1,2] InP [3] and GaAs nanowires, Ge, Si, GaN nanowires and GaN/AlN/AlGaN heterostructure nanowires, CdS nanowires, Si-CdS nanowire [4, 5] and many other single nano-devices from nanowires.

Metal Oxide materials like LaMnO3, SnO2, ZnO, Zinc Tin Oxide (ZTO), TiO2 as bulk materials and as nanomaterials have very a rich palette of physical phenomena. Most of them have isolator-metal phase transition (LaMnO3, ZnO, Zinc Tin Oxide (ZTO), TiO2), photo-luminiscence photoconductivity (LaMnO3, SnO2, ZnO, (Zinc Tin Oxide (ZTO)), TiO2,), and other interesting phenomena, like magnetic phenomena, including magnetocaloric, magnetoresistance, ferroelectricity. But the properties of these metal oxide as the nanomaterials, especially a individual nano-objects (nanowires, nanoparticles, etc) are almost not studied and thus their application for creation of single nano-devices is very rare in the literature. To such rare papers relate [6], where it was studied the field-effect nano-transistor (nanoFET), based on individual ZnO nanobelts and single nano-transistor, based on individual SnO2 nanowires [7] and ZnO Schottky diodes [5]. Thus the mentioned above metal oxide nano-materials, that have so a rich palette of physical phenomena up to now have not adequate place in nano-scale devices. The authors assume that the paradoxical situation is connected with the fact is related to insufficient knowledge of the properties of these metal oxide nano-materials as the individual nanowires, nanoparticles, and so on. On the other hand it is very complicated research to study individual nano-objects. That is why E-Asia consortia as the main idea of the present project maintains that metal-oxide nanomaterials have a very large application potential and also the potential of undiscovered physical effects that will be revealed if the size effects for individual nanoparticles and nanowires will be studied in detail. This fundamental study can ensure huge advanced frontier application. For example, because of the large surface-to-volume ratio, sensors based on individual nanoparticles, nanowires and nanotubes, in principle, can register insignificant amounts of chemicals or biomaterials, up to the attomolar level (1 aM = 10-18 M), as well as individual bacteria, viruses or even large molecules. There far-reaching suggestions are made that nanosensors based on individual nanoobjects can revolutionize the approach to medical diagnostics, sharply increasing accuracy, reliability, reducing the time of diagnosis, and, what is the most importantly, reduce the cost of medical analysis. It is predicted, that in the nearest future, nanobiotechnology-based lab-on-a-chip technologies will be widely customary available, such as cellular telephones and Internet.

To overcome the difficulties of the study of the individual nano-object is proposed the methodology based of the new frontier nano-manipulation system with the World's smallest mechanical nanotweezers. The elaborates nano-manipulation technology is large-scale (macro-scale), sub-nanometer precise, easy in use nano-instrument, consisting from nano-position system and micron size end-effectors controlled by semiconductor laser radiation or electric current with for frontier nanomanipulation in vacuum chamber or liquid environment in different microscopes. It can pick up and place, cut, pull, bend, turn, prepare the objects with the sizes from some nano-meters to 1micron. Such nano-device allows to select and to

deal with individual nano-objects. First of all the proposed technology for the first time allow easy to study individual nano-objects. On the Figure 1 a)-i) in shown the process of the selection of the some individual graphene layer from non-organic substrate, pick-up of these nano-objects, replace them to the other organic substrate.

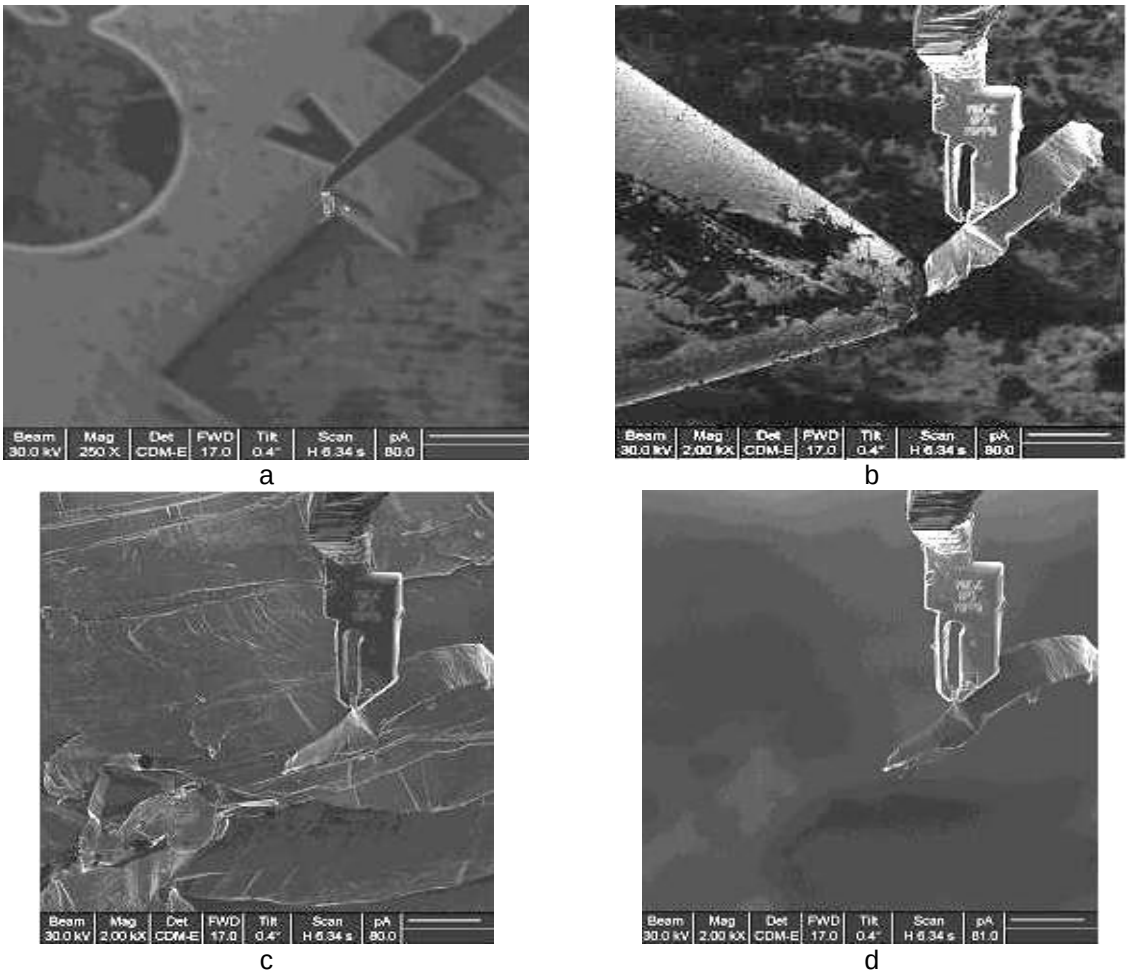

Figure 1 – a)-d) in shown the process of the selection of the some individual graphene layer from non-organic substrate, pick-up of these nano-objects, replace them to the other organic substrate

The process of the dealing with individual nano-objects one can see on videos:
https://www.youtube.com/watch?v=WFXMjqziX9w
https://www.youtube.com/watch?v=JtMdizCJReM
https://www.youtube.com/watch?v=1I5Gh6ffTIchttps://www.youtube.com/watch?v=5U1ZJ31yNwo
https://www.youtube.com/watch?v=OQ6MkleYKog
and it was reported in the articles [8-10].

Using this nanomanipulation technology and rather wide range of individual nanoobjects, in particular nanoparticles and nanowires ZnO, $LaMnO_3$, Fe_3O_4, TiO_2, ZnO, AuNPs/TiO_2, AuNPs/ZnO, (ZnSn)O, AgNPs, AuNPs, Ag nanowire, Ag QDs, created by the methods, described in [8-16] are investigated.

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