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Synthesis of nanometric iron oxide and chromium oxide films by reactive pulsed laser deposition for thermo sensors and thermo converters

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Ultraviolet photons of KrF-laser (248 nm) were used for the synthesis by reactive pulsed laser deposition (RPLD) of nanometric iron oxide and chromium oxide films with variable thickness, stoichiometry and electrical properties. Film deposition was carried out on <100> Si substrate at 293, 400, 600 and 800 K. XRD analysis showed that films deposited on Si substrate had polycrystalline structure. All films demonstrated semiconductor temperature behaviour with variable band gap E_g less than 1.0 eV depending on oxygen pressure, the number of laser pulses, substrate nature and its temperature. Film thickness of iron oxide (13-60 nm) depended on oxygen pressure, substrate temperature and number of laser pulses. Higher oxygen pressure and lower crystallinity of the deposited film was observed, resulting in decreased thermo electromotive force coefficient *(S)*. Higher substrate temperature (T_S), and more crystallinity of the deposited films, resulted in increased S coefficient. But optimum oxygen pressure (0.5 Pa) and substrate temperature when the S coefficient is as high as 3.0-8.0 mV/K was found in the range 280-330 K at T_S=800 K. The figure of merit is ZT=1-6 in the range 280-330 K with the maximum of 12 at 300-304 K. Film thickness of chromium oxide (55-200 nm) depended on oxygen pressure, substrate temperature and number of laser pulses too. It was found the optimum oxygen pressure (0.5 Pa) and substrate temperature when the S coefficient is as high as 2.5-8.0 mV/K and, accordingly, the figure of merit is as high as 0.23-5.0 in the range 280-330 K at T_S=800 K. When the S coefficient is as high as 1.5-1.9 mV/K, ZT is high as 0.20-0.56 at the same oxygen pressure and the same temperature range but at TS=293 K. Thermo-sensing characteristics of the films strongly depends on electrical and structural properties. So, nanometric iron and chromium oxide films synthesized by UV photons using RPLD method are up-to-date materials for effective thermo sensors and thermo converters operating at moderate temperature.

Biography

Viktor A Nikirin is Radiophysical Faculty of the National University (Kiev) in 2009. He did his PhD from the Institute of Semiconductor Physics, NASU and received scholarship of the Kiev mayor in 2013. Currently, he is a Senior Engineer. He has 4 papers and 3 patents in his name. He has participated in various scientific meetings and his research interests are synthesis of thermochromic films (VOx structures) and electrochromic films (WO3) and modification of thermo- and electrochromic films by ion implantation.

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