# Optimized growth of $VO_2$ thin films by metalorganic aerosol deposition

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$VO_2$ is a unique strongly correlated material that possesses a first order phase transition from tetragonal to monoclinic structure at near room temperature (68℃) with simultaneous ultrafast changes in electrical and optical properties. The exclusive properties of $VO_2$ make it challenging material for diverse applications, including, but not limiting to optical modulators, infrared bolometers and smart windows for energy-efficient buildings [1]. Majority of physical and chemical methods of thin film deposition have been utilized to $VO_2$, but for high-throughput manufacturing, which requested, for example, by the smart windows, atmospheric pressure chemical vapour deposition has significant advantages over other deposition techniques due to lack of vacuum and compatibility with on-line float-glass production. For this purpose we used the metalorganic aerosol deposition (MAD), which is a variation of atmospheric pressure CVD technique developed by our group [2].

Despite the fact that $VO_2$ was fabricated by the most of utilized deposition methods, the interval of technological conditions for a high-quality $VO_2$ formation has been found to be a very narrow due to a complicated structural phase diagram of vanadium oxide. Various oxidation states can be formed if oxygen pressure is not optimal, resulting thus in damping both the temperature of metal-to-insulator transition and the magnitude of resistivity change. The oxygen pressure at specific for MAD technology conditions is, therefore, the most important deposition parameter that has to be optimized first of all.

Here we present results of optimization of $VO_2$ thin films grown by MAD method at a variable partial oxygen pressure on different types of substrates such as $Al_2O_3(0001)$, $SiO_2/Si(111)$ and fused quartz glass. We varied the oxygen content, $O_2$ to Ar ratio in gas mixture, in the technological atmosphere keeping fixed all other deposition parameters such as substrate temperature, rate of deposition and total pressure inside the chamber. Analysis of crystal structure by X-ray diffraction, study of surface morphology by atomic force and scanning electron microscopy, study of the phase transition by temperature-controlled Raman spectroscopy (see Figure), measurements of transport and optical properties allows us to achieve formation of single phase $VO_2$. The optimized films possess the phase transition temperature, hysteresis width, and amplitudes of the optical and electrical changes that are corresponded to the high quality $VO_2$ thin films.

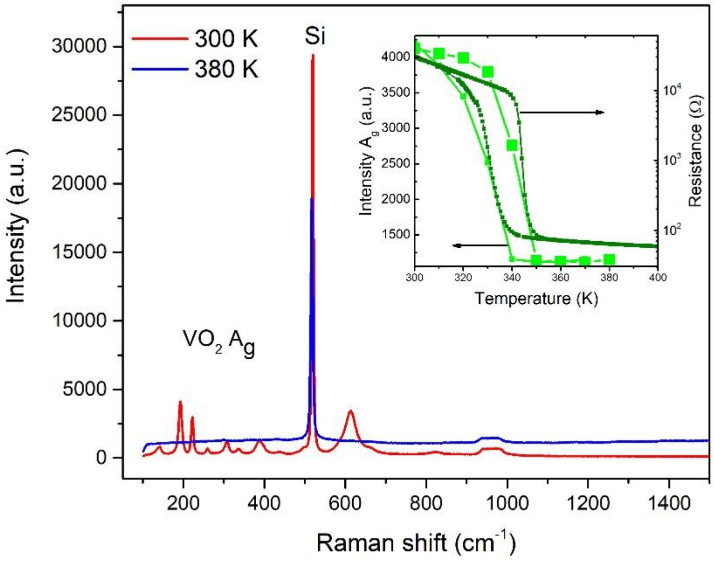

**Fig**. Raman spectra of $VO_2$ film for insulating (300 K) and metallic (380 K) phases. Insert shows temperature hysteresis of $A_g$ 196 $cm^{-1}$ line (light green). The hysteresis of resistance (dark green) is also displayed for comparison.

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References
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