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# Multifunctional device based on ZnO:Fe nanostructured films with enhanced UV and ultra-fast ethanol vapour sensing

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## Abstract:

Extensive application requests on high-performance gas sensors and photodetectors reveal the importance of controlling semiconducting oxide properties. Sensing properties of ZnO nano- and micro-structures can be tuned and their functional performances can be enhanced more efficiently by metal-doping. Here, we report the synthesis of crystalline Fe-doped ZnO (ZnO:Fe) nanostructured films via a cost-effective and simple synthesis from chemical solutions (SCS) approach followed by rapid thermal annealing (RTA) with excellent potential for the development of multifunctional devices for UV and ethanol ($C_2H_5OH$) vapour sensing. The effects of two types of thermal annealing on the ZnO:Fe morphology, the crystallinity, the electronic and the vibrational properties, the UV radiation and the gas sensing properties are investigated. The experimental results indicate an increase in UV response ($I_{UV}/I_{DARK}$~107) of as-grown ZnO nanostructured films by Fe-doping, as well as an essential improvement in rise and decay times due to RTA effects at 725°C for 60s. In comparison with un-doped samples, ZnO:Fe (0.24at%) specimens showed a response to ethanol which is enhanced by a factor of two, $R_{air}/R_{gas}$~61. It was demonstrated that by using Fe-doping of ZnO it is possible to reduce essentially the response $\tau_r$ and recovery times $\tau_d$ of the multifunctional device. The involved gas sensing mechanism is discussed in detail in this paper. The presented results could be of great importance for the application of RTA and doping effects for further enhancement of UV detection and gas sensing performances of the ZnO:Fe nanomaterial-based multifunctional device.