**Micro/nano-structures of transparent oxides by laser processing for optoelectronics and smart surfaces**

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The need for advanced materials and systems with new functionalities has motivated the development of micro/nanostructures on solid surfaces, which are necessary for the fabrication of functional devices for novel applications. In this talk, we will discuss the development of functional micro/nanostructures, based on transparent oxides combined with laser-processed surfaces.

Combining silicon micro/nanostructures with thin semiconducting ZnO films results in electronic heterojunctions with increased surface area for improved optoelectronic performance, especially for broadband photodetectors with enhanced photoresponse[1]. Furthermore, isotype heterojunctions of n+-ZnO/n-Si result in wavelength-selective, high-speed photodetectors with self-powered operation, which can be further engineered by careful selection of the electronic properties of the constituting materials[2,3]. “Smart” surfaces of controllable extreme wetting states are obtained by combining photoresponsive metal oxides with laser-processed micro/nanostructured substrates, which can reach complete water repellence without chemical modification[4]. Thin TiO2 films, immobilized on microstructured surfaces, show increased photocatalytic activity for the degradation of water pollutants and the development of water cleaning technologies[5]. Laser scribing of transparent, conductive oxide films, to be used as electrodes in thin-film photovoltaic systems will be discussed.

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**References**

1. G. Chatzigiannakis, A. Jaros, R. Leturcq, J. Jungclaus, T. Voss, S. Gardelis, and M. Kandyla, Laser-microstructured ZnO/p-Si photodetector with enhanced and broadband responsivity across the ultraviolet-visible-near-infrared range, ACS Applied Electronic Materials **2**, 2819 (2020).

2. G. Chatzigiannakis, A. Jaros, R. Leturcq, J. Jungclaus, T. Voss, S. Gardelis, and M. Kandyla, Broadband wavelength-selective isotype heterojunction n+-ZnO/n-Si photodetector with variable polarity, Journal of Alloys and Compounds 903, 163836 (2022).

3. M.D. Tsanakas, A. Jaros, Y. Fleming, M. Efthimiadou, T. Voss, R. Leturcq, S. Gardelis, and M. Kandyla, Wavelength-selective, high-speed, self-powered isotype heterojunction n+-ZnO/n-Si photodetector with engineered and tunable spectral response, Advanced Materials Technologies 10, 2401740 (2025).

4. M. Kanidi, A. Bardakas, A. Kerasidou, A. Anastasopoulos, C. Tsamis, and M. Kandyla, Hierarchical ‘rose-petal’ ZnO/Si surfaces with reversible wettability reaching complete water repellence without chemical modification, Applied Physics A 129, 320 (2023).

5. T. Giannakis, S.-K. Zervou, T.M. Triantis, C. Christophoridis, E. Bizani, S. Starinskiy, P. Koralli, G. Mousdis, A. Hiskia, and M. Kandyla, Enhancing the photocatalytic activity of immobilized TiO2 using laser-micropatterned surfaces, Applied Sciences 14, 3033 (2024).