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Precision Engineering of Functional NanoOxides at Industrial Scale: from Lab Scale Research to the TRL ladder.

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Metal-Oxides (MeOx) offer a fertile landscape in modern nanotechnology spanning fundamental-research topics to commercial-commodities. Current breakthrough in understanding of their physico-chemical properties that determine the desired functions of MeOx’s at the nanoscale, reveal that lattice-“nanoproperties” (quantum-size-effects, nanostrain, suface/bulk-defects, chemo-doping, spin-doping) are the key-parameters to control. In this endeavor, the transition from lab-scale to industrial-scale requires a mounting dexterity in synthesis methods that allow “precision-engineering” not just synthesis of the desired material phase.composition.

Herein we discuss current advances in Flame-Spray-Pyrolysis (a-FSP) technologies1,2 as a scalable technology that allows bridging the Lab-to-Industrial production of functional nanomaterials. We position precision-engineering by FSP-technologies at the Technology-Readiness-Level (TRL) ladder, as defined by NASA and the E.U. We highlight specific examples where precision-engineering of Transparent Metal Oxides (e.g. ZrO23, Tandalum-Oxides4, SnO25) by FSP allows their transformation to functional nanoplatfroms, with emphasis on energy technologies and sensing.

Within the TRL-frame of regulations, key-challenges in transforming the Lab-Scale finding to Industrial-Technology are highlighted from two perspectives: control of the desired properties and cost-efficiency.

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## *Embedding Pd into SnO2 drastically enhances gas sensing*

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