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Visible light-active nanorod-based metal oxide nanocomposites for direct solar-to-hydrogen generation

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The necessity of materials development which is not limited to materials that can achieve their intrinsic theoretical limits, but makes it possible to raise those limits by changing the fundamental underlying physics and chemistry is crucial. The demand of novel multi-functional materials is a major challenge for scientists to address to solve crucial contemporary issues related to energy, environment and health. For instance, one of the promising alternatives for the transition of energy resource from its fossil fuel-based beginning to a clean and renewable technology relies on the widespread implementation of solar-related energy systems, however the high cost of energy production and relatively low efficiency of currently used material combinations pose an intrinsic limitation. Indeed, (r)evolutionary development is required to achieve the necessary increases in efficiency and decrease in cost of materials for energy conversion. The need of low cost, purpose-built, functional materials with optimized morphology fabricated by cost effective large scale manufacturing methods will play a decisive role for a successful large scale implementation of solar-related energy source. Novel smarter and cheaper fabrication techniques and, just as important, better fundamental knowledge and comprehensive understanding of the structure-property relationships using materials chemistry and nanoscale phenomena to create multi-functional structures and devices is the key to success. Such an approach will be demonstrated by the design[1] and fabrication[2] of advanced quantum-dot, quantum rods and nanorod-based metal oxide nanocomposite arrays by aqueous chemical growth at low temperature, the in-depth investigation of their electronic structure and quantum effects at synchrotron-based facilities[3] and their application for direct solar hydrogen generation[4] and sensor technology[5].

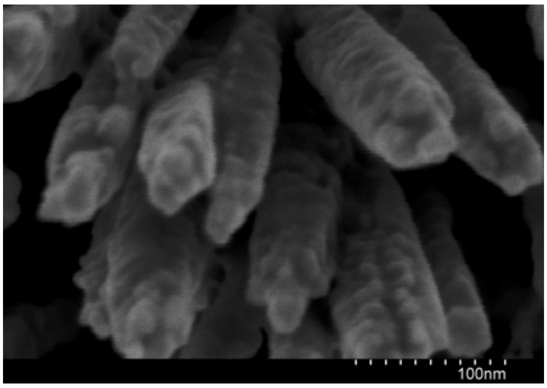

Figure 1: SEM image of an iron oxide-based semiconductor nanocomposite consisting of quantum-dot sensitized vertically oriented nanorod-array grown on commercial F-SnO_2 conducting glass substrate at 95°C.

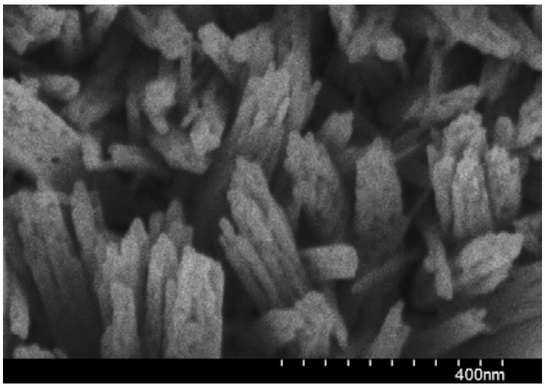

Figure 2: SEM image of a highly porous vertically oriented nanorod-array of iron oxide (Hematite) grown on commercial F-SnO_2 glass conducting substrate at 95°C from an aqueous solution of metal salts.

References

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