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Long-range, hysteresis-free and fast optical hydrogen sensing using transition metal hydrides

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KEYNOTE SPEAKER

Thin film metal hydride based optical hydrogen sensors provide an attractive option to sense hydrogen in a variety of conditions and have an attractive safety benefit over other methods of detection: They do not require the presence of electrical leads near the sensing area. These sensors rely on a change of the optical properties arising from a change in the hydrogenation of the metal hydride sensing layer in response to a different partial hydrogen pressure in the environment of the sensor. Often Pd-alloys are being used for this, since this material displays an optical change and is able to catalyse the hydrogen sorption. By using Pd-capped transition metals we split the catalytic and the sensing action which allows us to optimize both the kinetics, the optical contrast and the sensing range of the material. We demonstrate that Pd-capped Hf and Ta based thin films provide excellent opportunities to create sensors with a wide sensing range. In particular, Ta1−yPdy alloys allow for an extremely wide sensing range of at least seven orders of magnitude in hydrogen pressure. Nanoconfinement of the Ta1−yPdy layer suppresses the first-order phase transitions present in bulk and ensures a sensing response free of any hysteresis within a single thermodynamic phase. Unlike other sensing materials, Ta1−yPdy features the special property that the sensing range can be easily tuned by varying the Pd concentration without a reduction of the sensitivity of the sensing material. Combined with a suitable capping layer, sub-second response times can be achieved even at room temperature, faster than any other known thin-film hydrogen sensor.

Biography

Bernard Dam is a Dutch physical chemist who started his career with a thesis on the growth and morphology of incommensurately modulated crystals. After working as a researcher Philips Research Labs in Eindhoven on High-Tc superconductors and as an Associate Condensed Matter Professor at the VU University in Amsterdam, he is now the head of the MECS (Materials for Energy Conversion and Storage) group at the Delft University of Technology. In addition he is co-chair of the e-Refinery institute on electrochemical conversion. His present research ranges from in the investigation of metal oxyhydrides for photochromic and battery applications to the application of metal hydrides as optical fiber hydrogen sensors. The latter research shows the possibility to develop optical hydrogen sensors spanning six orders of magnitude in pressure.