Hydrogenography: identifying and tuning the thermodynamic properties of metal hydrides.

For a sustainable society, the development of a reliable and safe energy carrier is essential. The use of hydrogen as such a carrier has many advantages. However, hydrogen storage with a sufficiently high density and specific energy is still a problem. While metal hydride storage materials seem ideally suited for mobile applications, the use of PEM fuel cells imposes specific desorption conditions.
The search for new light-weight metal-hydride storage materials is essentially that for a needle in a haystack. Although computational methods have become more and more realistic, their predictive power is still limited. Experimentally, the determination of the plateau pressures of bulk samples is a very time consuming procedure. This explains the renewed interest in high-throughput experimental methods. We demonstrate that the change in optical properties on hydrogenation makes metal hydrides perfectly suited for a thin film combinatorial search for new hydrogen storage materials. This technique is not limited to systems with a metal insulator transition. We also apply it to hydrides that remain metallic. With our newly developed technique called 'Hydrogenography', we measure simultaneously the enthalpy of formation of thousands of hydrides on a single thin film wafer. Indeed, we find ways to destabilize existing storage materials. Besides the determination of thermodynamic and kinetic parameters of hydrogen storage materials, we use the technique to develop optical fiber hydrogen sensors and improved smart window devices.

Bernard Dam received his PhD in Nijmegen for a thesis on the 'growth and morphology of superspace crystals', i.e crystals with a fourth lattice periodicity. He spent six years at Philips Research Labs in Eindhoven investigating HT_c-superconductors and other functional complex oxides. Before becoming the head of the MECS group, he worked at the VU Condensed Matter Department. There he developed a research line focussed on the application of metal hydrides in sustainable energy applications, using a thin film combinatorial approach.