Raman Spectroscopy – A Swiss Army Knife for Thermophysical Property Research

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The optimization of established technological processes, as well as the development of new ones, plays a vital role in both industry and research. For gas separation, gas purification, and gas storage applications, accurate thermodynamic models describing different sorption effects and the behavior of fluid mixtures or fluid-solid systems are crucial. However, underlying mathematical approaches often suffer from insufficient and unreliable experimental data. One promising measuring technique to counter this problem and to provide high-quality experimental data for various thermophysical properties is the Raman spectroscopy. In this work, we demonstrate how this optical, non-invasive measuring technique can be used to investigate sorption phenomena such as absorption (e.g., solubility of gas in a fluid) and adsorption (e.g., adsorption of a gas on a translucent or opaque solid material), but can also serve as a monitoring tool for technological processes (e.g., observing ortho-para-hydrogen compositions in hydrogen applications down to cryogenic temperatures). The different approaches of conducting measurements and evaluating the recorded spectra are outlined and presented with exemplary results of various material and substance combinations. The talk should serve as an overview and provide a foundation for discussions addressing potentials, capabilities, and associated issues in utilizing Raman spectroscopy in these research fields. The methods presented are compared to other available measuring techniques, such as gravimetric and volumetric measurements, and their potential complementary combinations are discussed.