## A Combined Temperature Sensor and Phase Transition Detection Probe on a Single Optical Fiber

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Precipitation of solids is sometimes the goal, such as in sugar or sodium chloride production. Other times, it is undesired e.g. in the form of hydrate- or dry-ice-plugs in process equipment [1]. Fundamental knowledge of how the onset of solid precipitation is influenced by temperature, pressure, and composition is crucial for both of these examples, and is of great interest to both industry and academic environments.

Heterogeneous nucleation is usually the dominant mechanism when solid precipitation occurs, but the parameters involved are not well understood. An optical sensor that is able to detect a phase transition and the temperature at which it occurs is therefore of general interest for a wide variety of systems. In this work, we demonstrate how one fiberoptic sensor can be realized with generic phase transition detection. The sensor is based on a tilted fiber Bragg grating (TFBG)/in-line interferometer that is sensitive to both temperature and the surrounding refractive index (RI) [2]. The TFBG is fabricated by exposing a hydrogen loaded fiber to interference fringes of UV light at a tilted angle. This creates a narrow temperature sensitive – and surface insensitive – core mode reflection, in addition to a range of surface sensitive cladding modes. The temperature sensitivity stems from thermal expansion and the thermo-optic response of the fiber material, which alters the reflected wavelength. The change in RI induced by the phase transition can be detected, which together with the temperature measurement can be used to accurately determine the thermodynamic state when the phase change occurs. The sensor is demonstrated for deionized water, various NaCl solutions, ethanol mixtures, and acetic acid.

References:

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