Critical Micelle Concentration (CMC) Sensor Based on Porous Sol-Gel Doped Cladding U-Shaped Optical Fiber

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In our daily life, cleaning of clothes, washing of tableware, shampooing of our hair and etc. are utilizing a chemical activity of surfactant. All of these phenomena are based on chemical reaction of surfactant in the solutions. Surfactant solutions change the properties by forming micelles in the solution. It is called critical micelle concentration (CMC). Physical and chemical properties are drastically changed at this CMC point [1]. The detergency increases rapidly near CMC. After CMC the detergent activity saturates and reaches to be constant even if the concentration of the surfactant solution increase. Hence the most economical concentration can be found by the detection of CMC.

In this paper, a sol-gel derived coating U-shaped optical fiber sensors for measurement of critical micelle concentration of surfactants has been studied. The doped sol-gel cladding fiber was used to construct an active cladding U-shaped optical fiber CMC measurement sensor. The porous sol-gel film was deposited a 1000 μm core plastic clad silica fiber after removing the cladding of the fiber at the middle portion (6 cm) and bending in U-shaped design. CMC detection is based on an adsorption effect in sample solution of sodium dodecylbenzenesulfonate. The change in adsorption condition leads to an effective change in refractive index at the surrounding surface of the cladding [2]. The effect of bending radius and particle size of sol-gel cladding of U-shape on sensor sensitivity was studied and compared. Three different types of particles size of sol-gel porous cladding were tested in our lab. Test results show that the sensitivity of the small particle size porous sol-gel cladding U-shaped optical fiber in sensing region is higher than that of large particle size sol-gel cladding [Fig. 1]. The sensitivity of the sensor also increases when the bending radius of the U-shaped probes of the sensor decreases in all the three cases [Fig. 2].

References:

1. M. J. Rosen, Surfactants and interfacial Phenomena. New York NY: Wiley, (1978).

2. M. Ogita, Y. Nagai, M. A. Mehta and T. Fujinami, Sensors and Actuator B 64, 147 (2000).

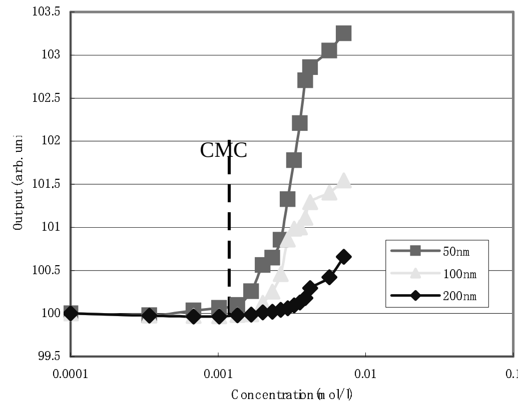

Figure 1. Output power vs. surfactant concentration for (a) 50 nm (b) 100 nm (c) 200 nm average particle size sol-gel cladding sensing region. The bending radius of U-shape probe is 1.5 cm

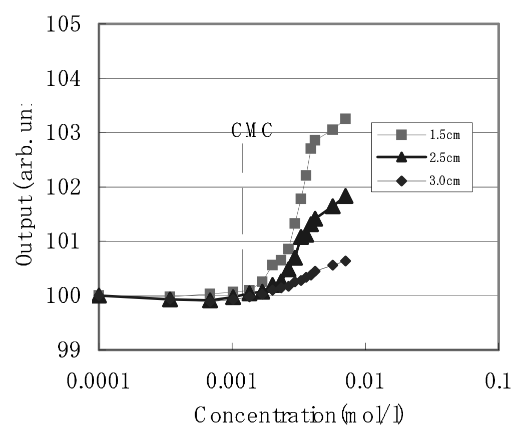

Figure 2. Output power vs. surfactant concentration for different bending radius of U-shape probe with 50 nm average particle size sol-gel coating. Upper curve correspond for bending radius of U-shape is 1.5 cm, middle curve is 2.5 cm and lower curve correspond to bending radius of U-shape is 3.0 cm