

# COPPER (II) DETECTION IN DRINKING WATER EXPLOITING A CHEMICAL SPR-POF SENSOR

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*A selective sensor for copper(II) detection in drinking water, exploiting a self-assembled monolayer (SAM) of D,L-penicillamine on a Surface Plasmon Resonance (SPR) plastic optical fiber (POF) sensor platform has been developed and tested.*

**Keywords:** Plasmonic chemical sensors, Copper(II)

## 1. Introduction

Copper(II) is an essential element for human health since it is a cofactor of many enzymes involved in chemical redox reactions, with antioxidant activity. Thus copper(II) is an essential nutrient so that the USA and Canada established a recommended dietary allowance (RDA) for adults of 900 µg/day. At the same time, it can be of concern for the human health when at high concentration, being able to induce oxidative stress by different mechanisms [1]. It appears to be involved in neurological disorders of high social concern as Parkinson and Alzheimer disease [2,3]. In the environment, copper(II) is mainly present in soil components, as clays, minerals and organic solids for example humic substances, due to the low solubility of many of its compounds and their easy adsorption. For these reasons copper(II) is usually present at low concentration in natural waters, but it can be at relatively high concentrations in drinking water at the tap. Actually, copper concentration in drinking water may increase during distribution, especially in waters with an acid pH or with high-carbonate content at alkaline pH (US EPA, 1995), because of the corrosion of interior copper plumbing. This seems to be the major source of copper in drinking water (US EPA, 1991; Health Canada, 1992; IPCS, 1998; US NRC, 2000) even if copper is widely diffused in the environment, having many other commercial uses. Many investigations from Europe, Canada and the USA indicate that copper levels in drinking water can range from 0.005 to >30 mg/litre. At concentration greater than 6 mg/litre it can have some detrimental effects on health causing nausea, vomiting, abdominal pain and cramps, headache, dizziness, weakness, and diarrhea [4]. From experiments on human volunteers it has been found that some symptoms appeared for copper(II) concentration in drinking water higher than 2 ppm [4]. A guideline value for the maximum concentration in drinking water has been established at 2 mg/L level. Sensing methods for in situ detection and analysis of copper(II) content in drinking waters should be of great help, and a number of them have been proposed. Beside more “classical electrochemical transduction, several surface plasmon resonance (SPR) based methods have been reported in recent papers [5-7]. SPR is an efficient marker free method for the detection and investigation of the interaction between an immobilized receptor and a substrate, highly sensitive, selective, fast and cost effective. The detection rely on the variation of the refractive index of the receptor layer in tight

contact with the metal surface at which the SPR is excited [6] when the substrate combines with the receptor. The aim of the present work is the development of an SPR sensor for copper(II) detection in drinking water, based on D,L-penicillamine as receptor over a POF (SPR-POF) platform. We have tested the SPR-POF sensor at different concentration of copper(II) in NaCl 0.1 M solutions at different pH values and in a real matrix (drinking water).

## 2. Sensor System & Experimental results

The optical chemical sensor device is shown in Fig. 1. It consists of an SPR D-shaped POF sensor platform, a white light source, and a spectrometer [8]. The gold surface of the SPR-POF probe was modified by building a self-assembled monolayer (SAM) of D,L-penicillamine [8]. By way of example, Fig. 2 shows the normalized transmission spectra obtained at different Copper(II) concentrations in a solution at pH=6.8 in the range from 0 M to 1.5 e-4 M. The detection range in real matrix (drinking water) is 3.9 µM – 0.1 mM [8].



Fig. 1 Picture of the chemical plasmonic sensor system.

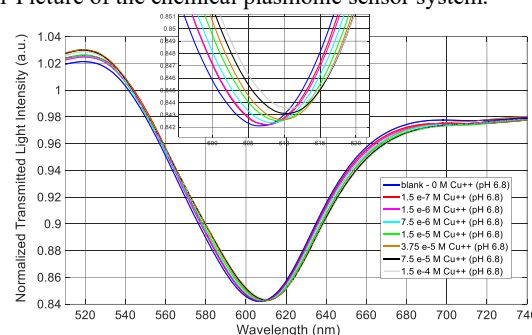


Fig. 2 SPR spectra obtained by SPR-POF sensor at different concentrations of Cu(II) in NaCl 0.1 M solution at pH=6.8.

## References

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