SENSING OF AN EXPLOSIVE PRECURSOR WITH ZEOLITE-MODIFIED CANTILEVERS

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The progress achieved in the field of chemical sensors during the last decade has been truly outstanding, leading to a continuous lowering of sensitivity limits. Regarding sensor selectivity, i.e., the ability of a sensor to discriminate among different analytes, advances have generally been achieved on an ad hoc basis, when a specific target has been identified for a certain analyte. Thus, high sensitivity has been achieved, or seems to be within reach, for many types biosensors, in view of the high specificity of biorecognition events. However, attaining high selectivity still remains a challenging task in many applications, with gas sensing being at the forefront.

A common strategy to attain higher sensitivity levels involves adding materials capable of molecular recognition to existing platforms of sufficient sensitivity, such as surface acoustic wave (SAW) devices, quartz crystal microbalances (QCMs) or cantilevers. For gas sensing this is generally realized using a variety of recognition elements have been used, such as polymer layers, carbon nanotubes and microporous solids. The latter hold considerable promise for gas sensing [1], in view of the intense guest-host force fields that are felt by fluid phase molecules capable of penetrating their cavities, where sizes range from a few angstrom to a few nanometers. These interactions are often selective, and can be used to implement molecular recognition functions.

Zeolites are perhaps the most widely employed silicon-based nanoporous solids. Their well defined pore of subnanometric size have earned them the name of molecular sieves, meaning that operation in the size exclusion regime is possible by selecting, among over 170 structures available, the zeolite whose pores allow the pass of the desired molecule, while keeping larger molecules outside. In addition, the adsorption properties of the zeolites can be fine-tuned by adjusting their Si/Al ratio and their exchange cations.

In view of their molecular sieving and selective adsorption properties, it is not surprising that zeolites have found use in a number of works dealing with gas sensing devices, either as a target or as a barrier to prevent the adsorption of interfering molecules. Thus zeolites have been used in electrochemical sensors, optical sensors, capacitors and of course mass sensors such as QCM and cantilevers [2]. However, the number of works that have coupled zeolites to cantilevers is very small, due in part to the difficulty of attaining homogeneous and reproducible zeolite coatings on cantilevers [3-8].

In the present work we have attempted a deeper study of the preparation of zeolite-modified cantilevers, studying how different methods can be used to obtain zeolite coatings of varied nature on cantilevers. We then proceed to show how the zeolites can be modified to increase the detection selectivity towards nitrotoluene, as an example of an explosives-related molecule. Figure 1 shows paddle-shaped cantilever appearance and dimensions and how the presence of Co in the zeolite improves the detection of nitrotoluene are shown in figure 2.

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Figures:

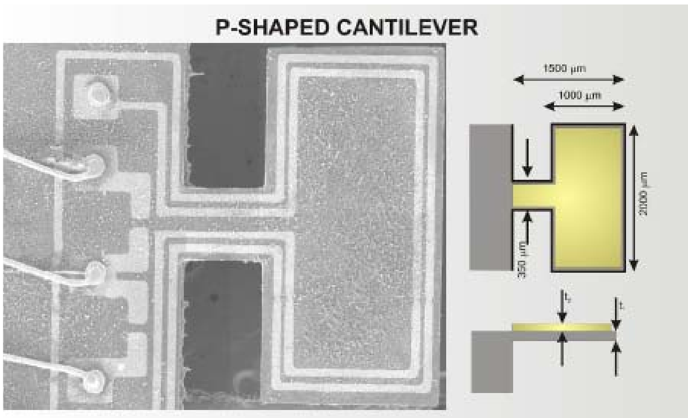

Figure 1: Top view photograph of the paddle-shaped cantilevers used in this work and scheme showing the main characteristic dimensions

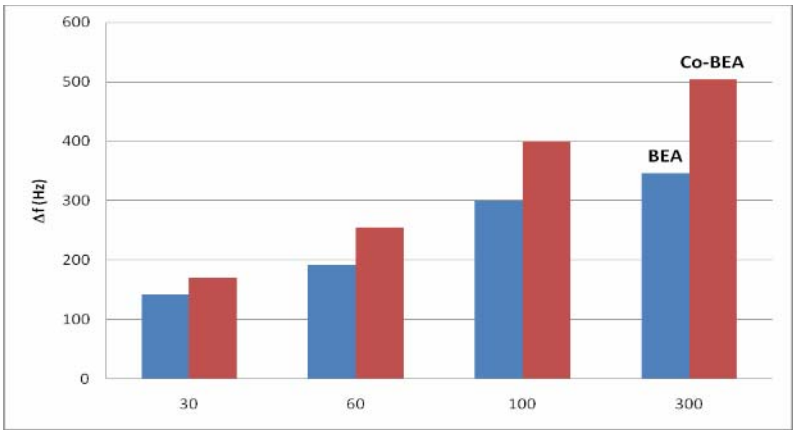

Figure 2: Comparation of o-nitrotoluene detection at room temperature on commercial QCMs loaded with as-received NH4-BEA and exchanged Co-BEA zeolites, respectively