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Mercury Detection by Metal-Oxide-Semiconductor (MOS) Structures

Fredrik Winquist and Ingemar Lundström

Laboratory of Applied Physics
Department of Physics and Measurement Technology
Linköping University S-581 83 Linköping Sweden

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Field-effect structures with (catalytically) active metals as gate materials have long been known as very sensitive detectors for, e.g., hydrogen, ammonia, unsaturated hydrocarbons and alcohols. In this paper it is shown that a large sensitivity for mercury vapor also can be obtained for these kinds of structures. Different metals of various thicknesses were investigated as gate materials, and the largest mercury sensitivity was obtained for the noble metals platinum, palladium and gold. The sensing mechanism is discussed. It is proposed that mercury not only easily forms alloys, amalgams, with these metals but also diffuses from the surface into the metal, even at room temperature, and apparently adsorbs at the metal-insulator interface. The response kinetics at different operating temperatures of the structures are described and discussed. The mercury sensitivity for a 1 mm^2 PdMOS capacitor was found to be around 1 ng, which is equivalent to about half a monolayer of mercury on the structure.

1. Introduction

Field-effect structures with catalytically active metals as gates have also been developed as very sensitive detectors for, e.g., hydrogen and ammonia. The first of this class of sensors was the hydrogen-gas-sensitive PdMOS (palladium metal oxide semiconductor) device, which was first described some ten years ago.[1] It was later established[2] that a large ammonia gas sensitivity can be obtained if a thin (3–10