Properties of Contacts and wire bonding for new generation of hydrogen and hydrogen compounds sensor

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INTRODUCTION

Palladium (Pd) is frequently used in sensor technology, especially in detection of hydrogen. It should be noted that this material is rather expensive, and its price is continuously rising. As far as PVD methods are concerned, the amount of material actually used is disproportionally small to the amount of material consumed in the process of applying. As an alternative, palladium compound can be used as its source. Moreover, they being used in the form of nanograins, it can help in the costs reduction.

EXPERIMENTAL DETAILS

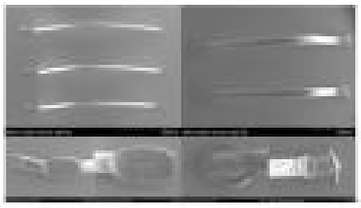
Nickel, titanium and nickel/titanium metal films were deposited on silicon substrates using the electron beam bombardment vacuum evaporation method. Different process's parameters such as deposition time (1–6 min), substrate target distance (9–15 cm) and power (1–2.5 kW) were used.

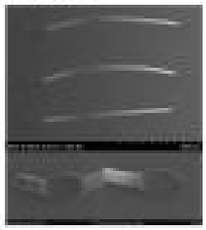
Micro connections were made by using the ultrasonic bonding technique. The processes were performed in two variants. In the first case, an aluminum wire of a diameter of 100 µm was used, and in the second case, a diameter of the wire was 25 µm. What is more, the thin wire consisted also of 1% of silicon, due to the different technique of the wire release after the second weld.

In order to measure microconnections' resistance, we use the micropull tester that allows the measurement of the force applied to the hook in the course of destructive testing.

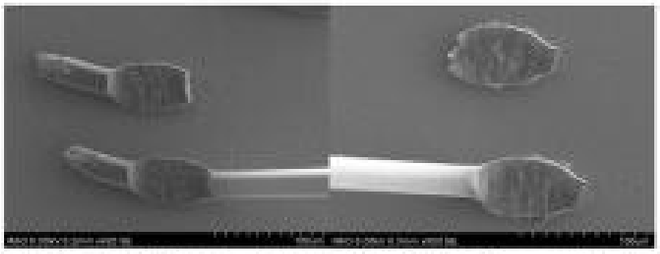
RESULTS Ultrasonic bonding

Example of ultrasonic bonding to titanium layers.





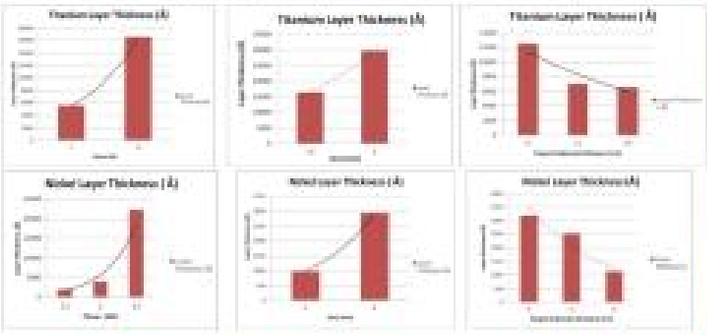
Example of ultrasonic bonding to nickel layers.



Broken connection for a double layer of Ni / Ti and their failure mechanism.

RESULTS

Influence of the deposition process parameters on thickness of deposited films



Results of SIMS measurements

RESULTS

The results of the pull tests of microconnections.

Sample	Ni		Ti		Ti/Ni	
Wire diameter [µm]	25	100	25	100	25	100
Average [mN]	77.5	523.8	66.3	-	72.4	548.6
Minimum [mN]	33	337	37	-	39	441
Maximum [mN]	97	714	82	-	93	726
Quartile 1 [mN]	75	553	58	-	68	513
Median [mN]	82	574	69	-	77	547
Quartile 3 [mN]	84.5	591	77	-	81.5	582
Standard deviation [mN]	15.6	91.1	12.3	-	13.6	59.4
Average deviation [mN]	10.6	63.1	8.9	-	10.3	42.5

CONCLUSIONS

The described findings have shown that it is possible to use a vacuum evaporation method assisted by the electron beam to produce contacts through the use of materials with high values of melting point. Moreover, from the microconnections point of view, the results indicate that the most favorable solution is the use of double-layer Ni/Ti structure. The structure retains the good bondability and electric properties of nickel. At the same time, it does not undergo the delamination due to the adhesive properties of titanium. The indicated contacts and wire bonding methods will be applied in practice to produce a hydrogen sensor. The selection of metals on the contact pads allows the use of detectors in above normative conditions, while the bonding allows the implementation of the cover assembly of structures. The choice of cover and its design is the subject for separate research.

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