Accepted Manuscript

Development and integration of near atmospheric N_2 ambient sputtered Au thin film for enhanced infrared absorption

Surender P. Gaur, Prateek Kothari, K. Maninder, Prem Kumar, Kamaljit Rangra, Dinesh Kumar

PII: S1350-4495(17)30008-7
DOI: http://dx.doi.org/10.1016/j.infrared.2017.03.013
Reference: INFPHY 2262

To appear in: *Infrared Physics & Technology*

Received Date: 4 January 2017
Revised Date: 21 March 2017
Accepted Date: 22 March 2017

Development and integration of near atmospheric N_2 ambient sputtered Au thin film for enhanced infrared absorption

Surender P. Gaur[1,2,*], Prateek Kothari[2], K. Maninder[2], Prem Kumar[2], Kamaljit Rangra[2], Dinesh Kumar[1,#]

[1]Electronic Science Department, Kurukshetra University, Kurukshetra-136119, India

[2]Sensors and Nanotechnology Group, CSIR-Central Electronics Engineering Research Institute, Pilani-333031, India

[#]Present affiliation: YMCA University of Science and Technology, Faridabad-121006, India

[*]Corresponding author email: surendergaur1@gmail.com

Abstract- The exceedingly fragile nature of thermally grown Au-black coating makes handling and patterning a critical issue. Infrared absorption characteristics of near atmospheric, N_2 ambient DC sputtered Au thin films are studied for this purpose. The thin Au films are sputtered at different chamber pressures in Ar and N_2/Ar gas ambient from 4.5 to 8.0 mbar and optimized for enhanced infrared absorption. The absorber film sputtered in N_2/Ar ambient at 8.0 mbar chamber pressure offers significant absorption of medium to long wave infrared radiations. The micro-patterning of sputtered Au thin film is carried out by using conventional photolithography and metal lift off methods on a prefabricated µ-infrared detector array on Si (100) substrate. The steady state temperature response of sputtered film has been examined using nondestructive thermal imaging method under external heating of the detector array.

Keywords: infrared, black Au, sputtering, infrared detectors, FTIR, thermal imaging.

1. Introduction:

The low vacuum, thermal evaporation deposited porous gold films possess spectral absorptivity from visible to far infrared radiations. These films have been utilized as infrared absorber coatings with uncooled infrared detectors [1-4]. The use of black coating effectively improves the sensitivity and reduces the response time in thermal sensors by increasing the heat generation process [6-8]. However, excessive thermal mass of an absorber can significantly enhance the thermal time constant that leads the slow response of sensor [5]. Especially, near atmospheric pressure thermal evaporated Au coatings offer high porosity, low density and very low heat capacity primarily required for efficient thermal enhancement in uncooled infrared sensors [3, 5].

The high pressure deposition of metal films result in high porosity and causes a number of handling and patterning related issues. The Au-black coatings are quite vulnerable to physical touch and even air currents [5, 10], consequently the absorber films are mainly deposited as the last step of fabrication process in single detector system or on the macro size detectors [8]. However, the high device density and co-existence of thermal and electrical field in an uncooled infrared detector demands selective deposition of absorber layers in thermal FPAs [10]. As the prolonged coating of absorber film not only enhances the chances of thermal crosstalk but can also cause the shortening of electrical contacts [9-11].

A few articles have been published over last few years for selective deposition and µ-patterning of black layers. The methods incorporate the shadow mask deposition [9-10], micro patterning of black Au after deposition of SiO_2 thin film as protecting layer [11] and hardening of Au-black by polymer infusion and aging [13-14]. Though each method listed above have its own drawbacks, the high porosity of Au black causes its dissolution in acetone [10-11], process complexity and degradation in IR absorption of SiO_2 over coated Au black, as the physical coating of SiO_2 suppress the porous Au-black and change its resistivity [11]. The polymer infusion causes collapsing of Au black due to heavy polymer chain interaction and results in enhanced optical reflection [10].

Thermal evaporation is the preferred way of depositing Au black coating in N_2 ambient at 100 Pa or more. In high pressure ambient the evaporated Au particles lose their kinetic energy due to the collision with N_2 molecules and become slower for pre condensed surface mobility at cooled substrate. The