DS 2 Optical properties of thin films II

Time: Monday 11:15–12:45 Room: GER 37

Invited Talk DS 2.1 Mon 11:15 GER 37

Phase Change Materials for Optical and Electronic Storage
— •Christoph Steimer, Ralf Detemple, Henning Dieker, Johannes Kalb, Daniel Wamwangi, Wojciech Welnic, and Matthias Wuttig — I. Physikalisches Institut 1A RWTH-Aachen, 52056 Aachen, Germany

Phase change materials are commercially used in rewritable optical storage and currently investigated as non-volatile electronic storage to replace conventional FLASH-memory. A short laser or current pulse of high intensity melts a sub-micron spot of crystalline material before quenching to the amorphous state. A second pulse of lower intensity but longer duration leads to a weaker spatial temperature profile and activates recrystallisation. Since reflectivity and conductivity of the amorphous state are lower, a third even weaker laser - or current pulse can be used to read out the state of the bit without changing it. As recrystallisation is the slowest process involved, materials with a small structural difference between the crystalline and amorphous phase promise higher data transfer rates. Such structural similarity however limits the optical and electronic contrast between the phases, i.e. readability, and the stability against spontaneous recrystallisation, i.e. data retention. Despite of their commercial application material development of PC-media still heavily relies on empirical approaches. This contribution summarizes recent progress in understanding how stoichiometry determines the structure of the crystalline and the amorphous phase and the resulting electronic differences.

DS 2.2 Mon 12:00 GER 37

Optical properties of reactively sputtered chromium nitride films
— •Kostas Sarakinos and Matthias Wuttig — I. Insitute of Physics (IA) RWTH Aachen University 52056 Aachen, Germany

A study of the optical properties of reactively sputtered Cr_xN_y (1<x< 2, y<1) films is presented. The films have been sputtered in an Ar/N_2 atmosphere at various values of the reactive gas (N_2) flow from 0-50 sccm. Since the phase formation and the stoichiometry of the films upon the variation of the N_2 flow has already been established [1], their effect on the optical properties is investigated. Spectroscopic Ellipsometry has been utilized for the optical characterization of the films. The ellipsometric spectra have been fitted using the combined Drude-Lorentz model. The unscreened Drude plasma energy has been used in order to monitor the evolution of the optical properties of the films. Films deposited at low N_2 flows exhibit high values of and thus metallic conductivity. On the other hand, above 19 sccm of N_2 flow , which is indicative for the absence of free electrons and electronic conductivity. The non metallic behavior above 19 sccm coincides with the predominance of a CrN_{1-x} phase with rocksalt structure. Samples above 19 sccm N_2 flow have been fitted with the Tauc-Lorentz model. Depending on the film stoichiometry within this regime a band gap up to 0.21 eV has been determined. This is in agreement with other experimental reports which state that the cubic CrN phase is a narrow band gap semiconductor.

[1] K. Sarakinos et al, submitted for publication

DS 2.3 Mon 12:15 GER 37

Film Thickness Dependence on The Optical Properties of Ni Thin Films
— •Farnaze Maghazeh[1], Hadi Savaloni[1,2], and Michael A Player[3] — [1]Plasma Physics Research Center, Science and Research Campus of I. A. University, P. O. Box 14665-678, Tehran, Iran — [2]Department of Physics, University of Tehran, North-Kargar Street, Tehran, Iran — [3]Department of Engineering, University of Aberdeen, Aberdeen AB24 3UE, U.

Abstract

Ni films of 30 to 130 nm thickness deposited on glass substrates, at 590 K substrate temperature. The optical reflectivity of samples were measured, using spectrophotometery method in the spectral range of 200 to 3000 nm. The optical functions of the films were obtained by Kramers Kronig method. The Effective Medium Approximation (EMA) analysis was used to establish the relationship between the structural changes through film thickness and EMA predictions. The predictions of the Drude free-electron theory are compared with experimental results for dielectric functions of Ni films of different thickness. The variation of both real part and imaginary part of the dielectric constant with film thickness is discussed. Keywords: Effective Medium Approximation (EMA); Optical functions; Substrate temperature; Kramers Kronig; Drude Model.

DS 2.4 Mon 12:30 GER 37

Substrate Temperature Dependence on The Optical Properties of Ti Thin Films
— •Haleh Kangarloo[1], Hadi Savaloni[1,2], Fahimeh Farid-Shayegan[1], and Michael Player[3] — [1]Plasma Physics Research Center, Science and Research Campus of I. A. University, P. O. Box 14665-678, Tehran, Iran — [2]Department of Physics, University of Tehran, North-Kargar Street, Tehran, Iran — [3]Department of Engineering, University of Aberdeen, Aberdeen AB24 3UE, U.K

Abstract

Ti films of 68 nm thickness deposited on glass substrates, at different substrate temperatures (Ts). Their optical properties were measured by spectrophotometery in the spectral range of 200 to 3000 nm. Kramers Kronig method was used for the analysis of the reflectivity curves of samples to obtain the optical constants. The influence of Ts on the microstructure of thin metallic films [Structure Zone Model (SZM)] is well established (Movchan and Demchishin (1969); Thornton (1975);Savaloni et al(1995, 2002)). The Effective Medium Approximation (EMA) analysis was used to establish the relationship between the SZM and EMA predictions. The predictions of the Drude free-electron theory are compared with experimental results for dielectric functions of Ti films of different Ts. The real part of the dielectric constant is increased with substrate temperature, while the imaginary part of the dielectric constant, in general, decreased with increasing the temperature over the whole energy range measured, including interaband and interband regions.