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PII: S0040-6090(18)30047-6
DOI: https://doi.org/10.1016/j.tsf.2018.01.031
Reference: TSF 36430

To appear in: *Thin Solid Films*

Received date: 17 July 2017
Revised date: 11 January 2018
Accepted date: 18 January 2018

Please cite this article as: Dustin Crouse, John Simon, Kevin L. Schulte, David L. Young, Aaron J. Ptak, Corinne E. Packard , Increased fracture depth range in controlled spalling of (100)-oriented germanium via electroplating. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Tsf(2017), https://doi.org/10.1016/j.tsf.2018.01.031

Increased Fracture Depth Range in Controlled Spalling of (100)-Oriented Germanium via Electroplating

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Abstract

Controlled spalling in (100)-oriented germanium using a nickel stressor layer shows promise for semiconductor device exfoliation and kerfless wafering. Demonstrated spall depths of 7-60μm using DC sputtering to deposit the stressor layer are appropriate for the latter application but spall depths <5μm may be required to minimize waste for device applications. This work investigates the effect of tuning both electroplating current density and electrolyte chemistry on the residual stress in the nickel and on the achievable spall depth range for the Ni/Ge system as a lower-cost, higher-throughput alternative to sputtering. By tuning current density and electrolyte phosphorous concentration, it is shown that electroplating can successfully span the same range of spalled thicknesses as has previously been demonstrated by sputtering and can reach sufficiently high stresses to enter a regime of thickness (<7μm) appropriate to minimize substrate consumption for device applications.

Keywords: flexible electronics, thin film, substrate reuse, germanium, fracture, spalling, layer transfer, exfoliation