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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 7-60 μm using DC sputtering to deposit the stressor layer are appropriate for the latter application but spall depths $<5\mu\text{m}$ 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 ($<7\mu\text{m}$) appropriate to minimize substrate consumption for device applications.

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

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