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Contribution of Lifshitz-Van der Waals Interactions to the Surface Energy γ^T of Si(100)-based Surfaces using the Van Oss-Young-Dupre Model

ALEX L. BRIMHALL, ASHLEY A. MASCARENO, ENDER W. DAVIS, Arizona State University Dpt. Physics, MATTHEW T. BADE, Arizona State University Dpt. Physics/Brophy College Preparatory, NITHIN KANNAN, ABIJITH KRISHNAN, Arizona State University Dpt. Physics/BASIS Scottsdale HS, NICOLE HERBOTS, Arizona State University Dpt. Physics, CLARIZZA F. WATSON, SiO2 Nanotech LLC, SIO2 NANOTECH LLC TEAM — Surface energy γ^T is studied via 3 Liquid Contact Angle Analysis (3LCAA) to optimize Wet NanoBonding$^{\mathrm{TM}}$, where surfaces hermetically cross-bond by anneal $< 200°$C. Applications lie in electronic sensors in saline environments. The Van Oss theory models interactions with dipoles (Lifshitz-Van der Waals) γ^{LW}, electron donors γ^+, and acceptors γ^-. Combining the equations of Van Oss and Young-Dupre yield the total γ^T and its 3 components. Contact angles for 3 different liquids are measured with the sessile drop method on 4-8 drops per liquid for accuracy, in a Class 100 hood. Si wafers are studied after RCA clean or Herbots-Atluri (H-A) processing. After H-A, 2 sets are treated with Rapid Thermal Anneal or Oxidation (RTA or RTO). γ^T is higher for the more defective, hydrophilic RCA cleaned Si ($47.3 \pm 0.5\frac{mJ}{m^2}$), while it is lower for the more ordered, hydrophobic H-A surfaces ($37.3 \pm 1.5\frac{mJ}{m^2}$) and RTO ($34.5 \pm 0.5\frac{mJ}{m^2}$). In addition, γ^{LW} interactions account for 90 to 98% of γ^T in ordered oxides, unlike in hydrophilic surfaces (76.5%). This indicates that 3LCAA can detect decreases in surface interaction from surface defects, impurities, and dangling bonds.

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