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Surface Energy Engineering (SEE) Correlated to Crystal Anisotropy of Piezo-Electric LiTaO3 for Nano-Bonding to Si and alpha-quartz SiO2 (T <453 K) SHREYASH PRAKASH, HEMANTH YALAHANKA, SHEFALI PRAKASH, MOHAMMED SAHAL, ABBIE ELISON, BRIAN BAKER, SAAKETH NARAYAN, LAUREN PUGLISI, ROBERT J. CULBERTSON, NICOLE HERBOTS, Arizona State U. Physics — One of the most piezoelectric materials, LiTaO3, is ideal for voice activated Si chips. Currently, heteroepitaxy (HE) and Direct Wafer Bonding (DWB) can't integrate highly anisotropic (c/a=2.7) trigonal LiTaO3 to cubic diamond Si (c-Si)– nor to trigonal alpha -quartz SiO2 (a-qSiO2, c/a=1.1). The lattice mismatch is 255%, thus HE is impossible. Moreover, the thermal expansion mismatch is huge. LiTaO3 expands 8X more than Si and 25X more than a-qSiO2. LiTaO3 decomposes into Ta2O5 and Li ions at T>673K so DWB and HE destroy LiTaO3. But this work uses Nano-Bonding (NB) at T<453K by Surface Energy γ Engineering (SEE) to modify surfaces into complementary, unstable states via 2D precursor phases catalyzing NB. Hydro-affinity (HA) and γ scales with surface interactions. Three Liquid Contact Angle Analysis (3LCAA) can measure HA and γ and map them along crystal directions. Contact angles on LiTaO3 are found to vary significantly by 40% with crystal direction. Anisotropy of HA correlates with γ. γ varies only 6% with crystal directions and yields insights into SEE.

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