In situ stress evolution in Ti/Pt multilayers during magnetron sputter deposition

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Control of stress evolution during film growth is crucial in many coating applications and requires *in situ* analysis. One such product is a micron-thick free standing biocompatible Ti/Pt multilayer film used as diaphragms for implantable inner ear microphones [1]. For a given size and thickness the diaphragm compliance and hence, the deflection can only be maximized if the intrinsic stresses in the thin film structure are zero. In this work, we have measured intrinsic stresses based on dynamic wafer curvature measurement using multiple laser beam deflection optical Stress measurements. The instantaneous stress state at any stage of Ti and Pt layer's growth and the final stress of a micron-thick film allows for direct feedback of the effects of deposition parameters. We investigated the influence of process pressure, target-to-substrate distance, target power, and influence of applied bias to the substrate- while keeping a low temperature- on the residual stress in Ti single-layered and Ti/Pt multi-layered films deposited on double-sided polished 150 μm thick Si(100) wafers using magnetron sputtering technique [2,3]. The example of stress evolution during the growth of a Ti single layer compared to oscillating stress state during Ti/Pt multilayer is shown in the figure. An excellent finding here is that tuning the layer thickness ratios in Ti/Pt multilayers particularly at the onset of growth up to 100 nm can be used to engineer the final stress state between compressive and tensile. This is attributed to Ti growing as type I (low mobility) generating tensile stress while Pt grows as type II (high mobility) generating compressive stress, at room temperature. The residual stress is also compared with post-deposition XRD wafer curvature measurement technique and differences along with the structural characterization of the films will be presented at the conference.

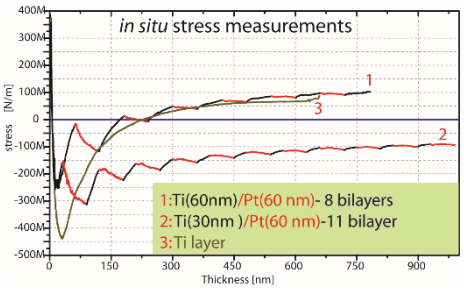

Figure: In situ stress evolution measured using MOS in single layer Ti and Ti/Pt multilayers on Si (001) substrates. The oscillations in the multilayer curves indicate that Ti and Pt change the stress direction from tensile to compressive, respectively.

[1] L. Prochazka, ..., F. Pfiffner, Sensors 4487, 19 (2019), https://hearmore.cochlear.com/
[2] D. E. Ibrahim, Master Thesis, LiU-IFM/LiTH-EX-A-20/3821-SE, (2020)-
[3] Prochazka, L. ***N.Ghaoor***, *et al.* Novel Fabrication Technology for Clamped Micron-Thick Titanium Diaphragms Used for the Packaging of an Implantable MEMS Acoustic Transducer. *Micromachines* **13**, 74 (2021).