ROLE OF FILM MICROSTRUCTURE ON INTERFACE STABILITY: IN-SITU AND EX-SITU INVESTIGATIONS

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Thin film adhesion is an important measure to quantify the stability of thin film – substrate interfaces. Film thickness, film microstructure, residual stresses as well as chemical reactions at the interface determine this value and it is often difficult to decouple each individual factor to study their influence on interface adhesion. In the following study the role of grain size on the interface stability was investigated for a model system at constant film thickness with comparable residual stresses. Therefore, 100 nm thin Cu films were sputtered on glass substrates. The film microstructure was tuned by a change of Argon pressure during deposition and by isothermal heat treatments post-deposition. To quantify the adhesion of the obtained Cu films, 500 nm thick, highly stressed Mo overlayers were deposited on the films leading to a spontaneous delamination at the Cu-glass interface in the shape of straight and telephone cord buckles. The model of Hutchinson & Suo could then be extended to a bilayer problem, allowing to determine adhesion for each Cu-glass system. The small grained films revealed improved adhesion compared to the large grained films. Detailed characterizations of the Cu film microstructures as well as the particular interfaces were conducted by means of transmission electron microscopy (TEM) and scanning electron microscopy (SEM). Finally, to study the plasticity mechanisms upon delamination, cyclic bending experiments were conducted in-situ in the TEM to observe the crack propagation towards the Cu-glass interface as a function of the film microstructure.

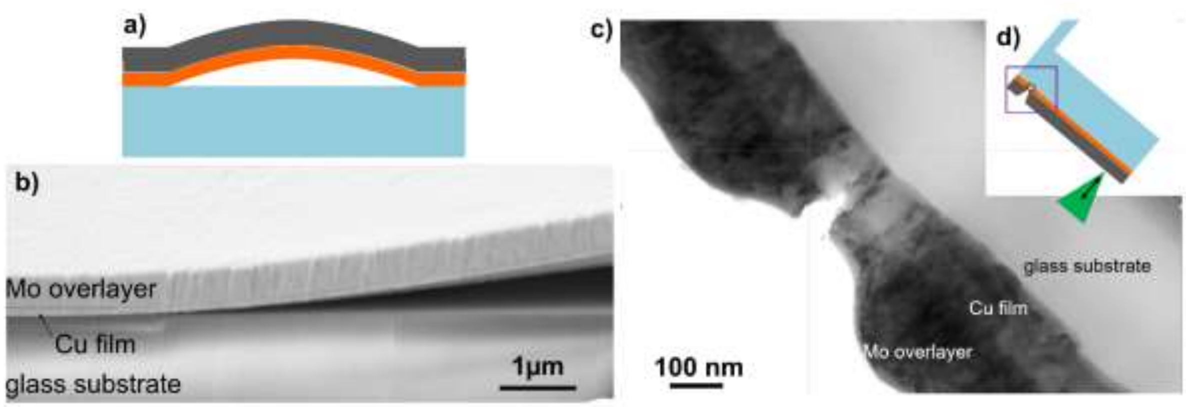

Figure 1. (a) schematic of spontaneous buckle (b) FIB cross section of delaminated Cu-glass interface (c) TEM setup: in-situ crack propagation towards Cu-glass interface (d) schematic of in-situ TEM setup