the years at CEMES. The “straining technique” was the first to emerge in earlier days of electron microscopy and despite being more confidential in the recent years, it has continued to produce valuable results. It allows to observe dislocation dynamics in wide area (several micron square) using conventional bright/dark field TEM imaging and electron diffraction, suitable to allow 1) observations of dislocations at the pertinent length scale (grain size) and time scale (few tens of ms) and 2) fast reciprocal and direct spaces analyses for orientation and 3D information retrieval. Instrumental set-ups make experiments available in a wide range of temperatures, enabling the investigation of thermally activated mechanisms. Contrary to actual nano-indentor set-ups, such straining holders cannot give access to the applied stress. However, observations of curved dislocations provide rich information on local stresses. Here, we will give few examples of observations in high entropy alloys, dilute solid solution alloys and pure metals, that allow to discuss plasticity mechanisms in particular with respect to macroscopic mechanical tests and discuss possible artefacts and caveats.

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15:00 “A novel combination of lab-on-chip testing, nanoscale DIC, and ACOM-TEM for unraveling plasticity mechanisms in UFG freestanding metal thin films”

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Nanocrystalline (nc) and ultrafine-grained (UFG) metals with grain sizes in submicron scales exhibit outstanding mechanical strength and fatigue properties compared to their coarse-grained counterparts. Thin films of nc or UFG metals are promising candidates for various structural and functional applications. However, their applicability is often restricted by the limited ductility exhibited by them due to low dislocation storage capacity within small-sized grains. Besides dislocation-based processes, the complex interplay of grain boundary (GB) mechanisms is well-known to control their plasticity. In the present work, elementary plasticity mechanisms are studied in UFG Al freestanding thin films with exceptional ductility (up to 17%). The mechanisms of plastic deformation are unraveled using a new combination of nanomechanical lab-on-chip testing with nano-scale digital image correlation (nano-DIC) followed by a correlative investigation by automated crystal orientation mapping in TEM (ACOM-TEM). nano-DIC allows for high-resolution quantification of in-plane shear strain along with the rigid body rotation of some clusters of grains across the specimen. The correlation of nano-DIC and ACOM-TEM measurements allows to distinguish intragranular and GB-mediated plasticity and offers a quantitative evaluation of the shear displacement at GBs. These results were further linked with the GB character, orientation, and defects in the deformed specimen. The combination of nano-DIC and ACOM-TEM brings new insight into the relation between local strain and microstructural features in nc FCC films based on a statistically representative study.