

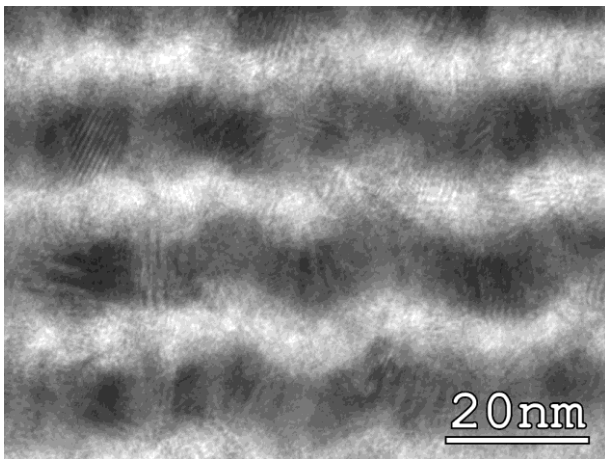
## NANOMECHANICAL TESTING OF Ti/Ni MULTILAYER THIN FILMS

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The main aim of the present work was to study the dependence of mechanical properties of Ti/Ni multilayer thin films on the thicknesses of constituent Ti and Ni layers. The multilayer thin films were made by depositing Ti and Ni layers alternately on single crystalline silicon substrates using magnetron sputtering method. Thickness of individual Ti and Ni layers varied from 1.7 nm to 100 nm, the total multilayer thickness was around 1  $\mu\text{m}$ . The mechanical properties were characterized by means of nanoindentation experiments using a Hysitron dual head T1950 triboindenter equipped with diamond Berkovich tip in both static and dynamic loading regime in the load range from 50  $\mu\text{N}$  to 11 mN. Moreover, nanoindentation tests were performed at elevated temperatures up to 500  $^{\circ}\text{C}$  using a Hysitron xSol heating stage. The nanoindentation data were evaluated using the recently developed home-made Nanoindentation General Evaluation Tool (NIGET) [1] software for independent analysis of loading and unloading curves which includes among others a basic treatment of uncertainties and systematic errors that are missing in commercial software provided together with instrumented indentation testing devices. The NIGET software has a graphical interface which uses libraries of the open source software Gwyddion [2]. The nanoindentation results were correlated with microstructure studies using XRD (X-ray diffraction technique), a Tescan LYRA 3XMU FEG/SEMxFIB scanning electron microscope (SEM), a Philips CM12 STEM transmission electron microscope (TEM) and a JEOL JEM-2100F high resolution TEM. Thin lamellar cross sections for TEM observations were prepared using a focused ion beam (FIB) in SEM from two locations in each sample: an undisturbed layer and a central region of indentation print made with Berkovich tip with a relatively high load from the range of 0.5 to 1N.



An example of the Ti/Ni multilayer microstructure with bilayer thickness of 20 nm is shown in Fig. 1.

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[1] <http://www.nanometrologie.cz/niget/>

[2] <http://www.gwyddion.net>

*Figure 1 – A HRTEM micrograph of alternating nanocrystalline Ti and Ni layers.*