Direct and Indirect Magnetic Force Microscopy in Histology

Iron (Fe) is an essential metal involved in a wide spectrum of physiological functions. Sub-cellular characterization of the size, composition, and distribution of ferritin(iron) can provide valuable information on iron storage and transport in health and disease. While histochemical stains (e.g. Perls stain) can provide a rapid evaluation of iron, their spatial resolution is limited. Magnetism-based microscopy can serve as an attractive approach to characterize iron deposits in situ in biological tissue sections. In this study we employ the scanning probe based technique, namely magnetic force microscopy (MFM) to map sub-micron iron deposits in tissue sections. We demonstrate how MFM can identify ferritin(iron) rich lysosomes in tissue sections compatible with histochemical staining. Quantitative analysis of MFM data can reveal differences in lysosomal ferritin(iron) content. We further present a novel indirect MFM technique, which preserves the high spatial resolution and sensitivity of the conventional or direct MFM but enables high-throughput detection of magnetic domains. In indirect MFM an ultrathin membrane separates the sample and the MFM probe, thus minimizing the effect of sample topography in MFM imaging. Samples prepared for indirect MFM are compatible with multimodal imaging using light and electron microscopy. We thus elucidate the potential of direct and indirect MFM in analyzing iron content in histology.