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The Application of Specular X-ray Reflectivity to Characterize Patterned Surface WEN-LI WU, HAE-JEONG LEE, CHRISTOPHER L. SOLES, NIST — Specular x-ray reflectivity (SXR) has been used extensively for thin film characterization and depth profiling. Recently its application has been extended to quantify nanoscale patterns made of photo lithographic polymers. SXR results complement small angle x-ray scattering measurements by providing details information in the cross section of features on nanoscale surface patterns. This talk is to focus on the limit of applying SXR as an effective surface pattern metrology. Polymeric line gratings with periodicities or pitch ranging from 200 nm to 16 μm were chosen as test samples and it is expected that as the pitch size reaches beyond the coherent length of x-ray SXR will no longer be applicable. The optics of the SXR instrument dictates the coherent length of the x-ray; it provides a coherent length of a few micrometers in the longitudinal direction and sub-micrometers along the lateral direction on the reflection plane and a few nanometers along the lateral direction perpendicular to the reflection plane. SXR measurements were made at various azimuthal angles between the incident x-ray beam and the line grating, with 0° being the incident beam parallel to the line grating and 90° being perpendicular to each other. For periodicities less than 900 nm, the perpendicular and parallel measurements yield comparable SXR results which can be quantitatively analyzed using a one-dimensional model invoking effective medium approximation (EMA), i.e. SXR measures the lateral average electron density of the surface pattern. For periodicities 900 nm and greater, EMA breaks down and the SXR results can not be analyzed using any one-dimensional model. Work is on-going to determine the nature of transition between the EMA applicable region and the inapplicable region. The effect of surface patterns irregularity on this SXR application is another topic of current study.

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