Figure 2. a)-e) Layer structure and f)-j) their magnified view of a series of tantalum structures deposited at a deposition angle \( \alpha \) of 80° with decreasing growth pitch \( P_\omega \). The growth pitch can be used directly to adjust the micro-structure.

Figure 3. Procedure to evaluate the dominant spatial frequency from a SEM image. a) Starting point is a SEM image of the top view of tantalum columns produced with GLAD, b) power spectral density of the top view according to Eq. (4), where high gray values are colored red and the ring-shaped pattern is revealed; c) plot of the angular averaged power spectral density according to Eq. (5) with marking of the dominant spatial frequency \( f_r^* \). The range of variation \( f_{r,max} - f_{r,min} \) of the dominant spatial frequency is defined by the half width (dashed line) (Buzea et al. (2005)).

The angular-averaged power spectral density \( R_{PSD} \) (Zhao et al. (2001)) by:

\[
R_{PSD}(f_r) = \frac{1}{n_r} \sum_{n=0}^{n_r} \text{PSD}(x_f, y_f) ,
\]

(5)

with the number of pixels \( n_r \) on the circumference of the circle with the radius \( f_r \) given by:

\[
f_r^2 = x_f^2 + y_f^2.
\]

(6)

All points on the circumference of this circle, whose center lies in the center of the PSD image and thus also in the center of the ring-shaped structure, represent a constant spatial frequency \( f_r \). The angle between a point on the circumference and the center of the circle represents a direction in the original image. Eq. (5) thus averages the power spectral density across all directions in the original image so that the dominant spatial frequency \( f_r^* \) can be read from the maximum of the direction-averaged power density as a function of the spatial frequency (Fig. 3c). Thus, the dominant column spacing \( r^* \) is

\[
r^* = \frac{1}{f_r^*}.
\]

(7)