Directed self-assembly (DSA), an emerging lithographic technique, has attracted increasing attention as a result of its advantages of low cost, high throughput and convenient processing. However, DSA still presents some challenges, such as the control of defects, the fabrication of complex patterns and pattern registration. In this work, self-assembling morphologies of the lamellar diblock copolymer poly(styrene-b-methyl methacrylate) were investigated to gain a better understanding of the DSA process and to offer some reference for the pattern transfer process. A quantized number of lines was obtained in the directing grooves, although warps and dislocations appeared when the number of lines jumped from n to (n + 1). Gradational variations in line width were observed near the edge of the confining grooves, which shows the lack of uniformity in the patterns. A novel structure model is proposed to interpret this variation in the block copolymer lines. Valuable information and insights are provided for nanowire patterning by DSA in state-of-the-art semiconductor devices.