

Development of neutron optics with a curved supermirror

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We are developing real curved supermirror, which is deposited neutron supermirror on the substrate with a curved surface. First in our sputtering machine, we manage to keep the uniformity of layer thickness over the large area of tens to a hundred centimeter for large substrates with flat surface. But, when the curvature of surface is large and the surface is not considered to be flat, it's not easy to deposit supermirror uniformly on the curved surface as we can do on flat substrate. We then have to make the layer-thickness distribution to have conformity to curved surface, or find the way to compensate for the distribution.

We, at first, made the mask which is the meshes with stainless wires of 0.3mm in diameter in order to keep the uniformity of layer thickness over 300mm long area. Two kinds of meshed patterns and blank area were used for 300mm long substrate. Fig. 1 shows the sputtering rate in the case of with the mask and without the mask versus the position on the sample stage of our sputtering machine. The position $x=0$ is the center of the stage. We succeeded to decrease the differences of layer thickness from 28% to 4% between the center and the edge on the sample stage.

Second, we deposited 2.5Qc supermirror on the substrate with an ellipsoidal surface on which substrate 2.0Qc supermirror was requested. The performance of 2.5Qc to 2.0Qc supermirror was kept at the thinnest area to the thickest area, since the maximum reduction of the layer thickness was estimated to be 27% in the ellipsoidal surface. Fig. 2 shows the neutron reflectivity of 2.5Qc supermirror fabricated with the mask. The mirror has the performance of 2.1Qc supermirror and the neutron reflectivity at 2.0Qc was 95%. The supermirror is deposited on a flat substrate of Si at the center of the sample stage.

Next, we have to find the way to keep uniformity of layer thickness on the surface with large curvature. The larger distribution of layer thickness yields stronger stress in the layers. It thus results in the peeling layers off the substrate and prevents from developing higher-Qc supermirror with curved surface.

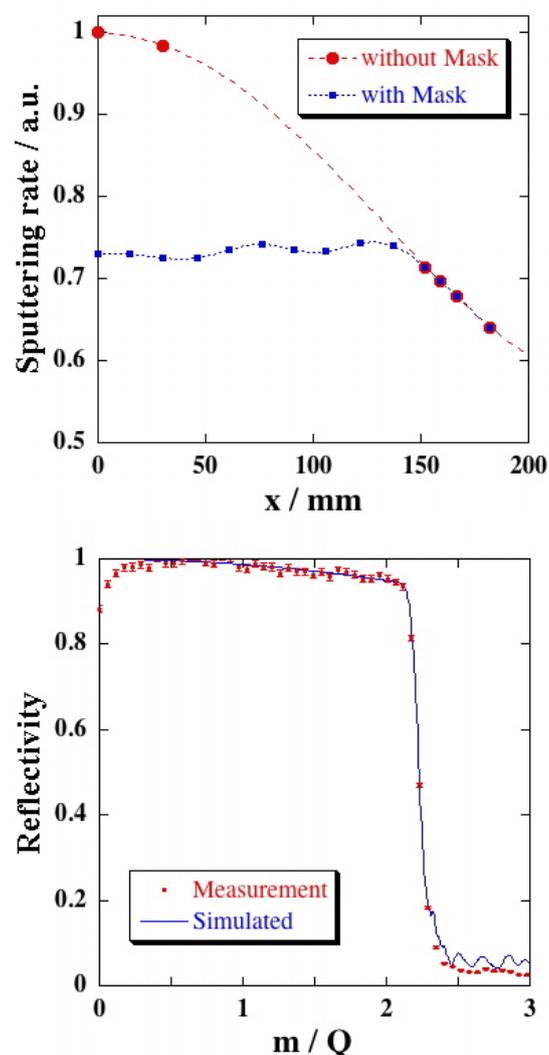


Fig. 1. Sputtering rate in the case of with the mask (circles) and without the mask (squares) versus the position on the sample stage of our sputtering machine. Fig. 2. Neutron reflectivity of 2.5Qc supermirror fabricated with the mask.