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Morphological evolution on pre-rippled surface by crossing ion beam sputtering

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Low energy ion beam sputtering has been widely studied for an effective way of making self-organised nanostructures such as periodic ripples, nano-dots and nano-pores. Nevertheless, most of the patterns was produced on flat surface, and limited to dot and ripple patterns. In this work, we show the evolution of pre-rippled Au(001) by crossing ion beam sputtering(CIBS) perpendicular to the pre-patterned ripple.

Pre-patterned ripple is gradually destroyed and then vanished ultimately, and at the same time new ripple pattern develop along the crossing ion beam direction. This negates the recent theoretical proposal of nano-sculpturing through sequential ion beam sputtering. The surface roughness, W, decreases exponentially in the early stage of CIBS and then increases as the power law with a large growth exponent, $\beta = 0.96$. The wavelength of pre-patterned ripple increase as the power law with $1/z = 0.63$. In contrast, the wavelength of new ripples increase following logarithm function. These logarithmic coarsening could not be explained by previous models, while it is well reproduced by the hydrodynamic model which takes the effect of redeposition into account that is neglected by previous models. To explain our result of sputter induced smoothing, we performed classical molecular dynamics (MD) simulation. In our MD simulation, sputter induced erosion and reposition are all found to significantly contribute to the evolution of the ripple patterns. . To acquire the insight of the morphology evolution during CIBS, we also made numerical studies of KS equation which exclude the effect of redeposition. However, it fail to reproduce the experimental result, confirming that the redeposition should play an essential role in morphology evolution during CIBS.