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The Effect of crystal Orientation Distribution on Sputtering Rates in Polycrystalline Tungsten by Low Energy Ar Plasma

低エネルギーArプラズマによる多結晶タングステンのスパッタリングに及ぼす結晶方位分布の影響

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Introduction

Polycrystalline Tungsten (PCW) will be used in plasma facing components (PFC) such as divertors in fusion reactors [1]. One form of plasma control in fusion reactors is Ar-seeding [2]. Ar plasma would sputter W atoms, which decreases the lifetime of the PFC's and affects plasma stability. Sputtering yield has been shown to be affected by crystal orientation of the target metal [3], but no experimental data has been studied for the effect of crystal orientation on the sputtering yield of W yet. Therefore, this study analyses the relation between the crystal orientation distribution and sputtering yield of PCW, specifically made for the ITER outer divertor.

Experiment

Various PCW samples were prepared by different fabrication methods, including ITER PCW, different roller directions and recrystallization. Samples were sputtered with low energy 100 – 200 eV Ar plasma. EBSD was used to measure the crystal orientation. A laser microscope was used to measure the sputtering depth after sputtering and total mass loss was used to estimate the sputtering yield.

Results

Fig 1. Shows comparison between the sputtered depth and crystal orientation after Ar sputtering. The sputtering rate decreases in the order (110) > (100) > (111). The total sputtering yield is similar for all our samples and are within 30% of each other.

Discussion

The sputtering depth for different crystal orientations is monotonically related to the "transparency" of the crystal orientations. This may indicate that more channeling in the more "transparent" crystal orientations such as (111) for W, causes less sputtering. This is in agreement with the single crystal experiments done by Onderdelinden [4].

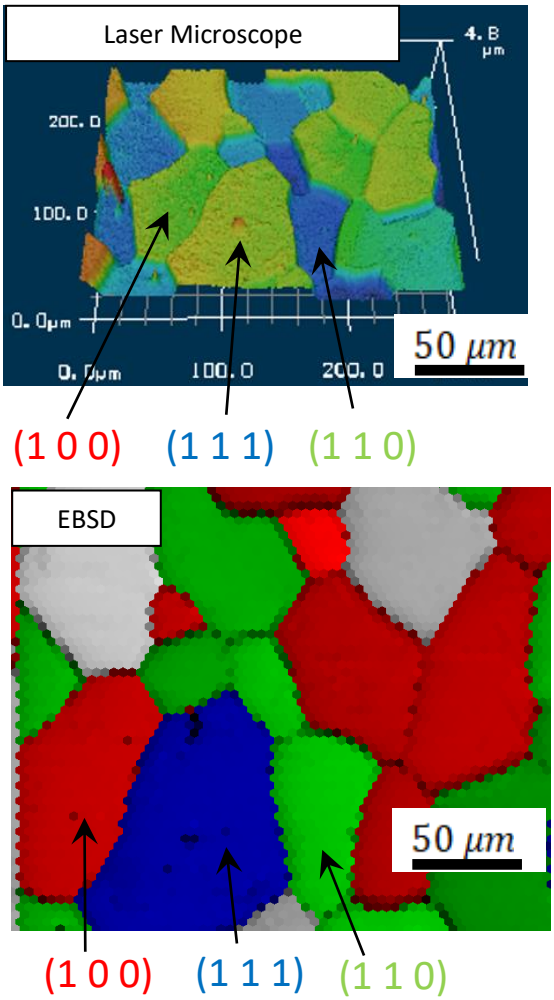

Fig 1. Laser microscope depth map and EBSD image of recrystallized W after Ar sputtering.

Conclusion

The effect of the crystal orientation on sputtering yield from Ar plasma exposure has been shown experimentally in PCW. The results suggest that the sputtering rate is the lowest for (111).

References

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[3] R. Behrisch, et.al., Topics in Appl. Physics 110, 33-187 (2007) Springer-Verlag Berlin Heidelberg
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