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The effect of the surface patterning by ion beam irradiation on the Ag directional outflow in Ag/AlN nano-multilayers

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Nano-multilayers (NMLs) are functional nano-architectures, which physical properties can be tailored by smart microstructural and interfacial design. Upon thermal treatment, the layered structure of NMLs of immiscible metals degrades, resulting in surface metal filler outflow. The local driving force of the outflow can be modified by external NML surface modification.

In the present work, the effect of surface patterning by focused ion beam in the intensity of Ag surface outflow was investigated in Ag/AlN NMLs. Ag/AlN NMLs were prepared by magnetron sputtering. Afterwards, five narrow lines were sputtered by He-ion focused ion beam (FIB) Zeiss Orion Plus machine. Analysis of the outflow phenomenon was conducted by *in situ* imaging of NMLs heated up in the vacuum chamber of Auger electron spectroscopy instrument. Investigation showed that the amount of Ag crystals formed in the region patterned by ion beam is larger rather in the intact area. It is proposed that FIB patterning can be potentially used as a novel technique for the controlled surface outflow in Ag/AlN NMLs [1].

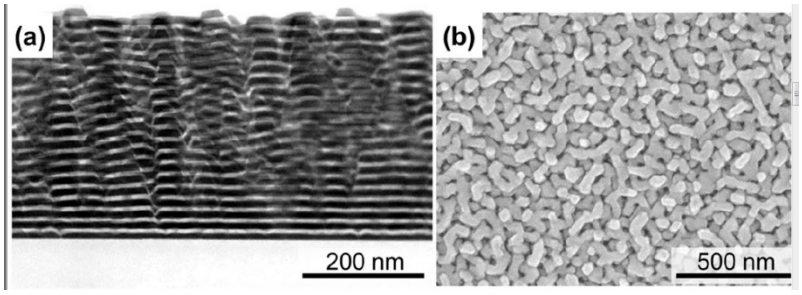

Fig. 1. Cross-section (a) and surface (b) SEM images of the as-deposited Ag/AlN NML for annealing in AES machine (20 bilayers). Reprinted with permission from Ref. [1]. Copyright 2023 Elsevier.

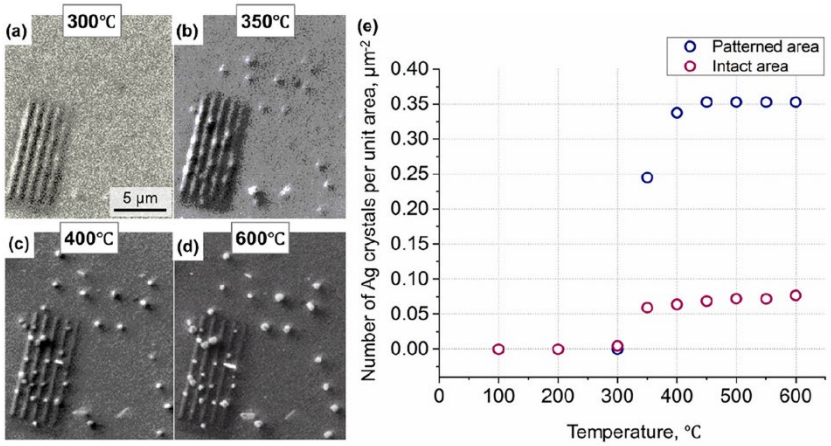

Fig. 2. (a–d) Secondary electron micrographs of the patterned NML surface acquired in AES vacuum chamber during in situ heating up to 600 ◦C. (e) Number of Ag particles per unit area in patterned and intact surface regions during in situ heating. Reprinted with permission from Ref. [1]. Copyright 2023 Elsevier.

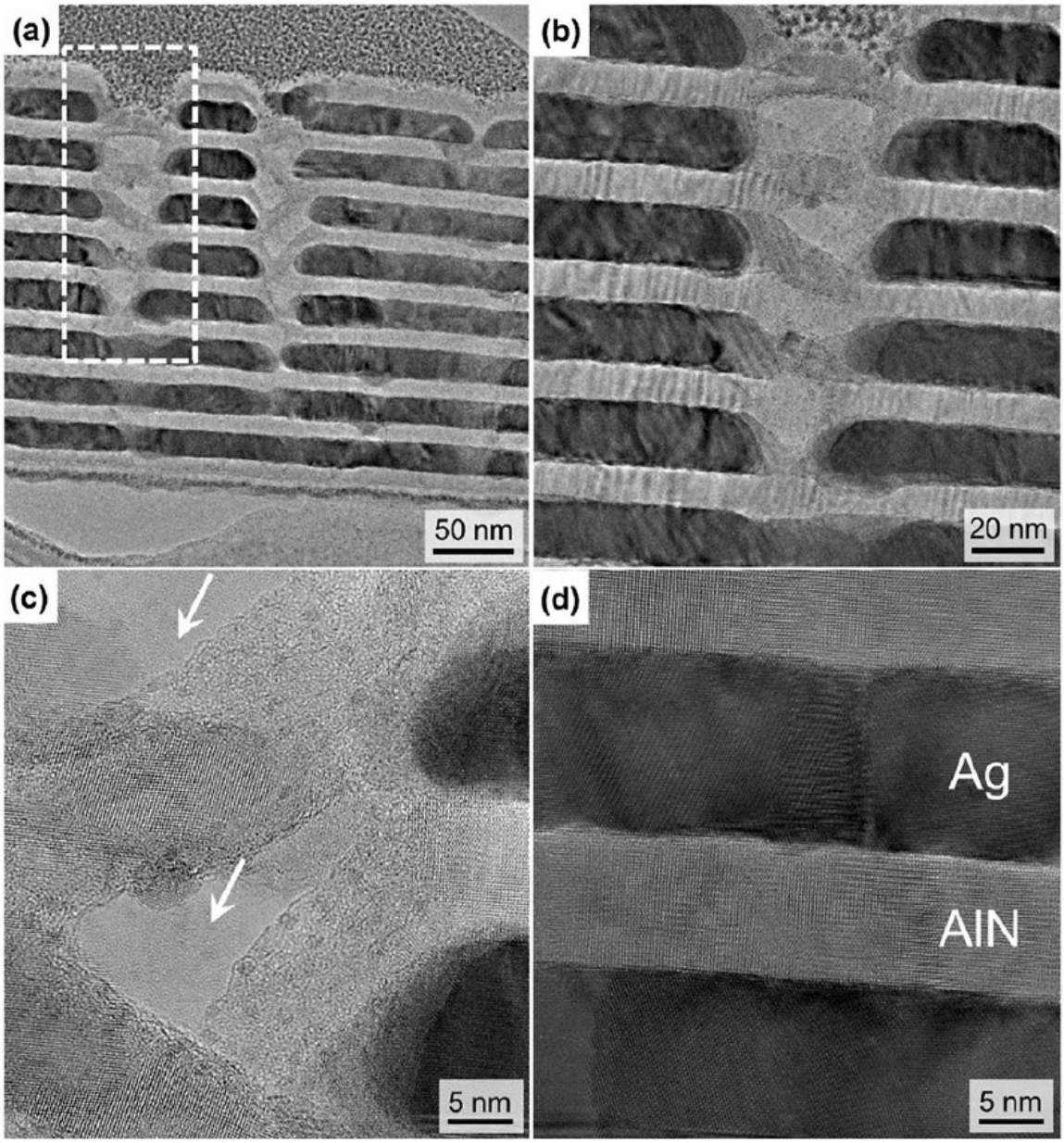

Fig. 3. Cross-section TEM images of Ag/AlN NML (10 bilayers) annealed at 650 ◦C for 30 min in vacuum furnace (area, intact by HeFIB). (a) Survey image of the carrot-like channels formed upon annealing (Pt cover layer is visible in the upper part of the image). (b) High-magnification image of the channel highlighted in (a). High-magnification images of regions inside the channel and close to the substrate surface are shown in (c) and (d) respectively. White arrows in (c) highlight voids in the NML volume. Reprinted with permission from Ref. [1]. Copyright 2023 Elsevier.

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Reference

[1] A.V. Druzhinin, C. Cancellieri, R. Hauert, E.A. Klyatskina, N.N. Khrapova, A.A. Mazilkin, B.B. Straumal, J. Janczak-Rusch. The effect of the surface patterning by ion beam irradiation on the Ag directional outflow in Ag/AlN nano-multilayers. Vacuum 210 (2023) 111850.