Supplementary Information

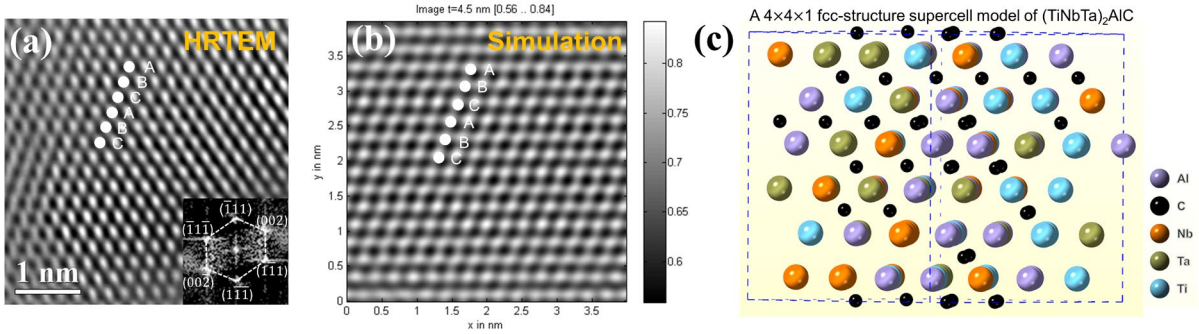
Distinct Amorphization Resistance in High-entropy MAX-phases (Ti, *M*)$_2$AlC (*M*=Nb, Ta, V, Zr) Under *in situ* Irradiation

Hao Xiao [a,1], *Shuang Zhao* [a,1], *Jun Zhang* [b,1], *Shijun Zhao* [b], *Youbing Li* [c], *Ke Chen* [c], *Liuxuan Cao* [d], *Yugang Wang* [a], *Qing Huang* [c], *Chenxu Wang* [a,*]

[a] *State Key Laboratory of Nuclear Physics and Technology, Center for Applied Physics and Technology, Peking University, Beijing 100871, China.*
[b] *Department of Mechanical Engineering, City University of Hong Kong, Hong Kong 999077, China*
[c] *Ningbo Institute of Material Technology & Engineering, Chinese Academy of Sciences (CAS), Ningbo 315201, China*
[d] *College of Energy, Xiamen University, Xiamen 361102, China*

Supplementary Note 1. Phase contrast simulation of the fcc-phase

Supplementary Figure 1(a) shows the HRTEM micrograph of (TiNbTa)$_2$AlC irradiated at a dose of 7.2 dpa (derived from a crystalline area in Fig. 3(d)), which exhibits an fcc-structure with ABCABC… stacking sequence. Supplementary Figure 1(b) shows the simulated phase contrast image along $[11\bar{2}0]$ zone axis of a random fcc-(TiNbTa)$_2$AlC SQS supercell (solid-solution in cation sites, as shown in Supplementary Figure 1(c)) via the QSTEM program, the thickness and defocus are set as 4.5 nm and -61.3 nm, respectively. It is revealed that the simulation result is consistent with the experimental HRTEM micrograph. Phase-contrast simulation in (TiNbTaVZr)$_2$AlC shows analogous results (not presented in the manuscript).



[1] These authors contributed equally to this work.

Supplementary Figure 1 **(a)** HRTEM micrograph of $(TiNbTa)_2AlC$ irradiated at a dose of 7.2 dpa, with an fcc-structure (crystalline area in Fig. 3(d)). The electron beam is along $[11\bar{2}0]$ direction and inset shows the corresponding FFT image. **(b)** The simulated phase contrast image along $[11\bar{2}0]$ zone axis (thickness and defocus set as 4.5 nm and -61.3 nm, respectively) of the fcc-$(TiNbTa)_2AlC$ supercell via the QSTEM program. (c) A 4×4×1 fcc-structure supercell model of $(TiNbTa)_2AlC$ used for the phase contrast simulation.

Supplementary Note 2. Proportion of the elemental components:

The proportion of the elemental components in $(TiNbTa)_2AlC$ and $(TiNbTaVZr)_2AlC$ is given in the Supplementary Table 1, which is cited from Ref 1[1]. The proportions of the elemental components in the M-site of $(TiNbTa)_2AlC$ and $(TiNbTaVZr)_2AlC$ are close.

Supplementary Table 1: The elemental proportion of $(TiNbTa)_2AlC$ and $(TiNbTaVZr)_2AlC$[1]

	Elemental proportion (at.%)						
	Ti	Nb	Ta	V	Zr	Al	C
$(TiNbTa)_2AlC$	7.97	8.50	7.90	-	-	11.54	64.09
$(TiNbTaVZr)_2AlC$	6.82	7.55	7.85	6.22	4.51	14.59	52.46

Supplementary References

1 Chen, L. *et al.* Multiprincipal Element M2FeC (M = Ti,V,Nb,Ta,Zr) MAX Phases with Synergistic Effect of Dielectric and Magnetic Loss. *Advanced Science* **10**, doi:10.1002/advs.202206877 (2023).