Electrochemical analysis of nanoporous silver foams through chemical dealloying for different structures in Al-Ag alloys

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Abstract

In this paper, de-alloying mechanism of Al–Ag alloys was investigated by microstructure and electrochemical noise (EN). Based on the energy distribution plot (EDP) obtained from the EN data, it is demonstrated the type of de-alloying for $Al_{70}Ag_{30}$ was Al dissolution mainly, resulting in non-uniform nanoporous structures. For $Al_{60}Ag_{40}$, it was mainly γ-Ag_2Al dissolution, producing coarser nanoporous structures. For the $Al_{65}Ag_{35}$ locating near the eutectic point, the de-alloying mechanism was the concurrent uniform dissolution of α-Al and γ-Ag_2Al, resulting uniform nanoporous structure.

Results and discussion

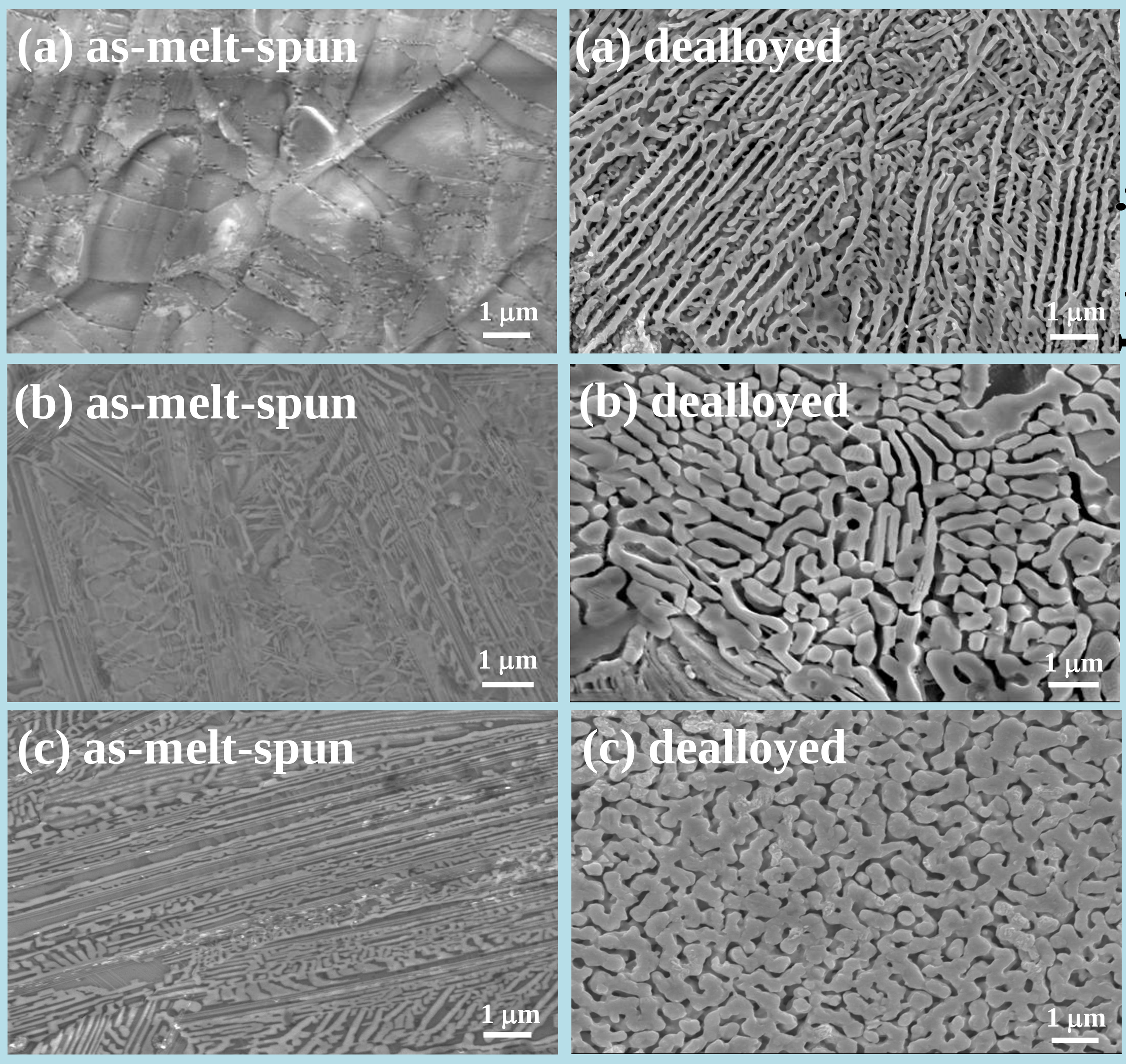

Figure 1 SEM micrographs of the different samples under the as-melt-spun and the dealloyed conditions for 30 min: (a) $Ag_{30}Al_{70}$, (b)$Ag_{35}Al_{65}$, and (c) $Ag_{40}Al_{60}$.

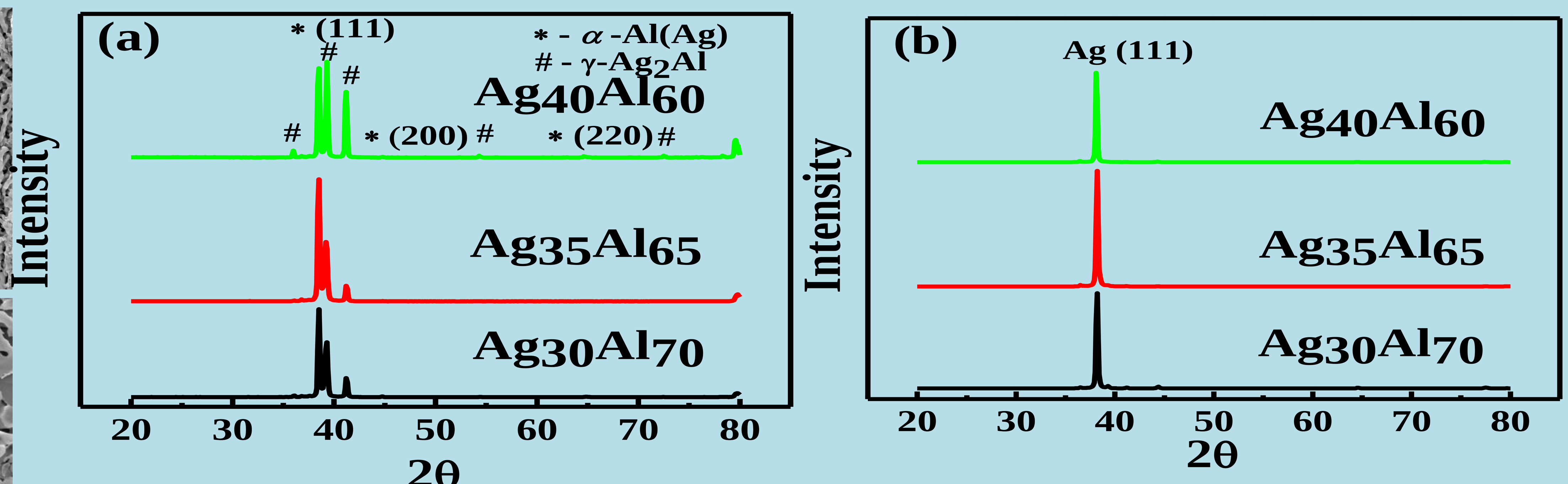

Figure 2 XRD patterns of Al–Ag samples under the (a) as melt-spun and (b) dealloyed condition for 30 min.

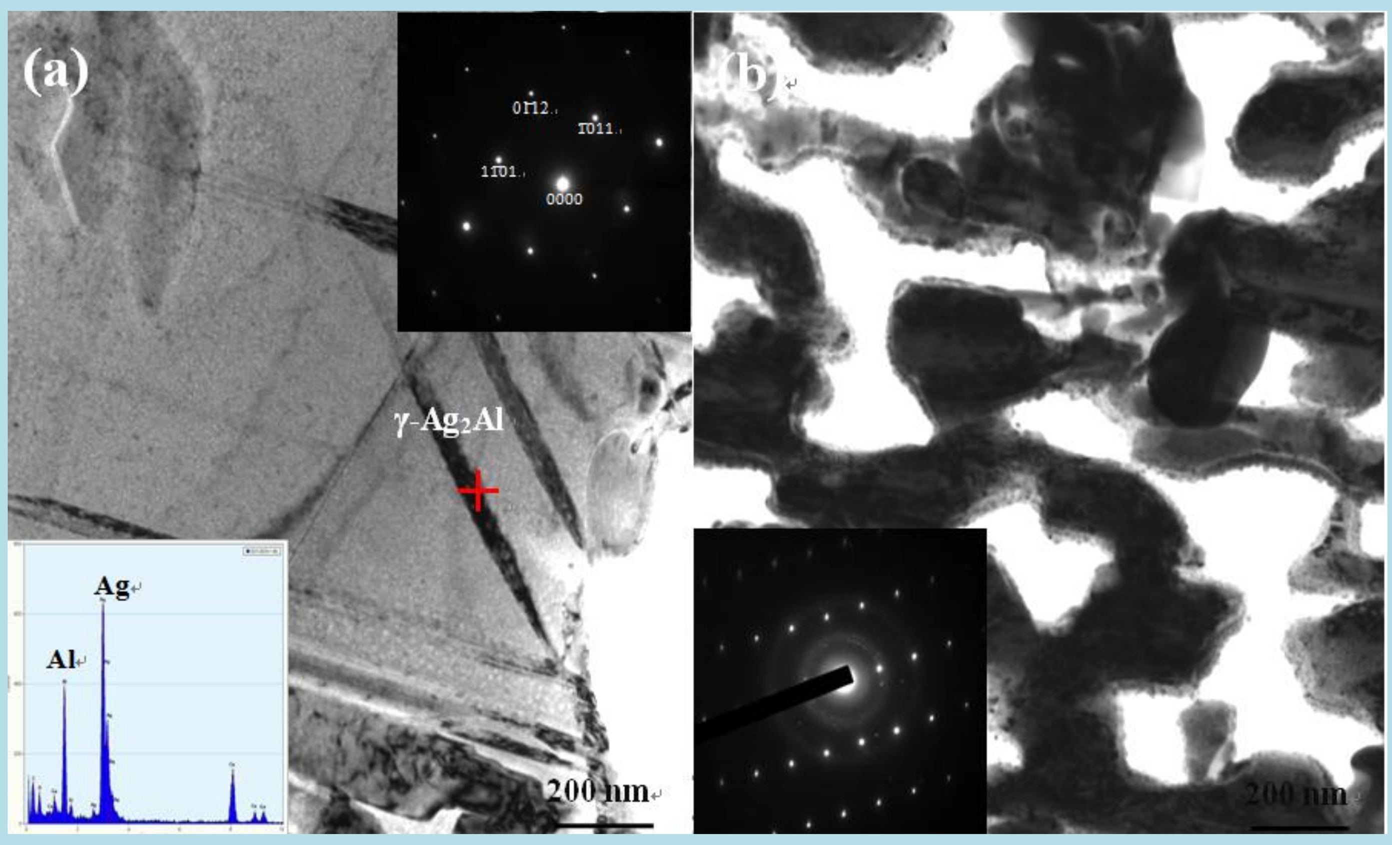

Figure 3 TEM micrographs of the $Ag_{35}Al_{65}$ samples (a) as-melt-spun, (b) dealloyed for 30 min.

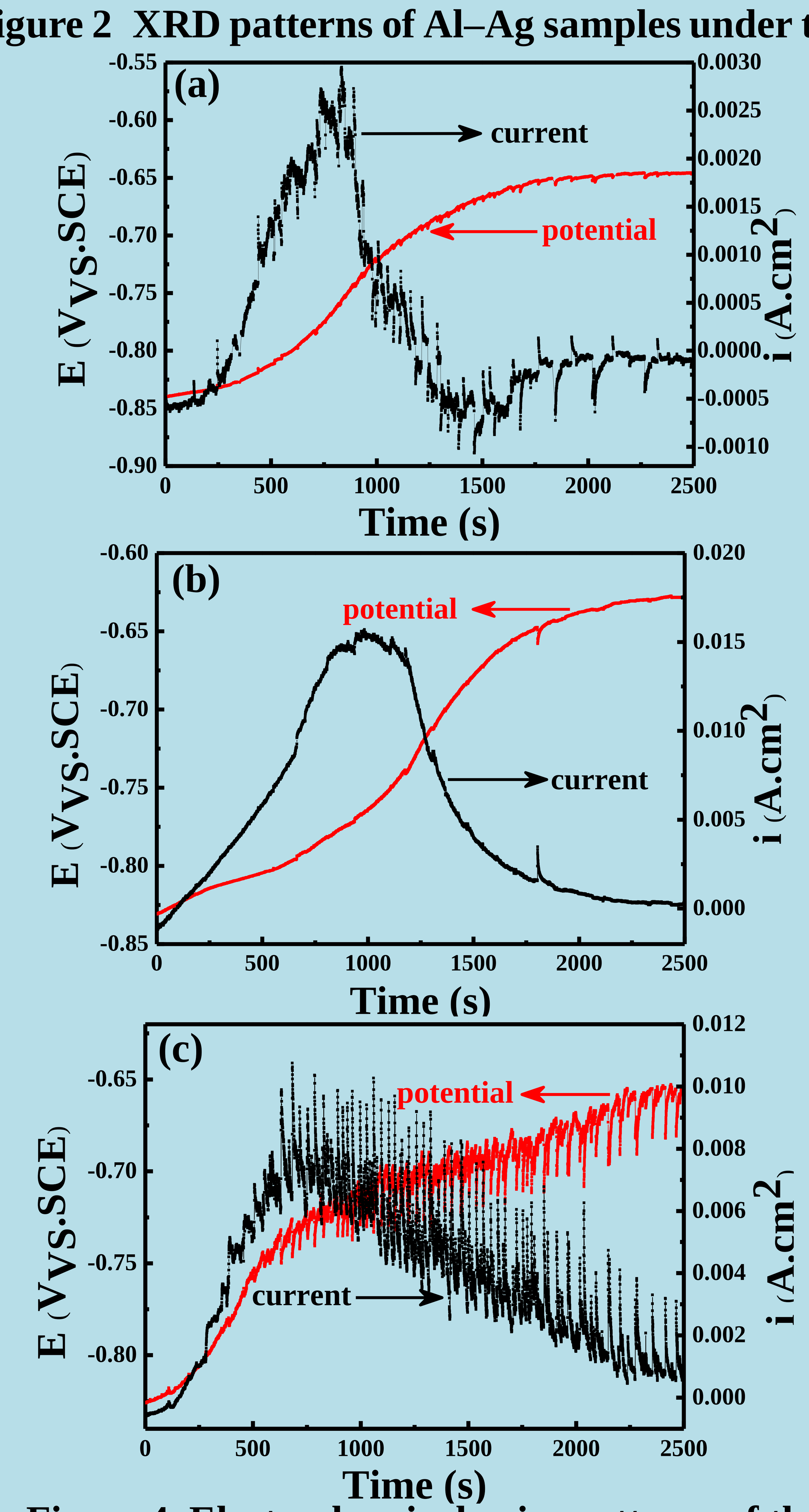

Figure 4 Electrochemical noise patterns of the Al–Ag samples as a function of dealloying time: (a) $Ag_{30}Al_{70}$, (b) $Ag_{35}Al_{65}$, and (c) $Ag_{40}Al_{60}$.

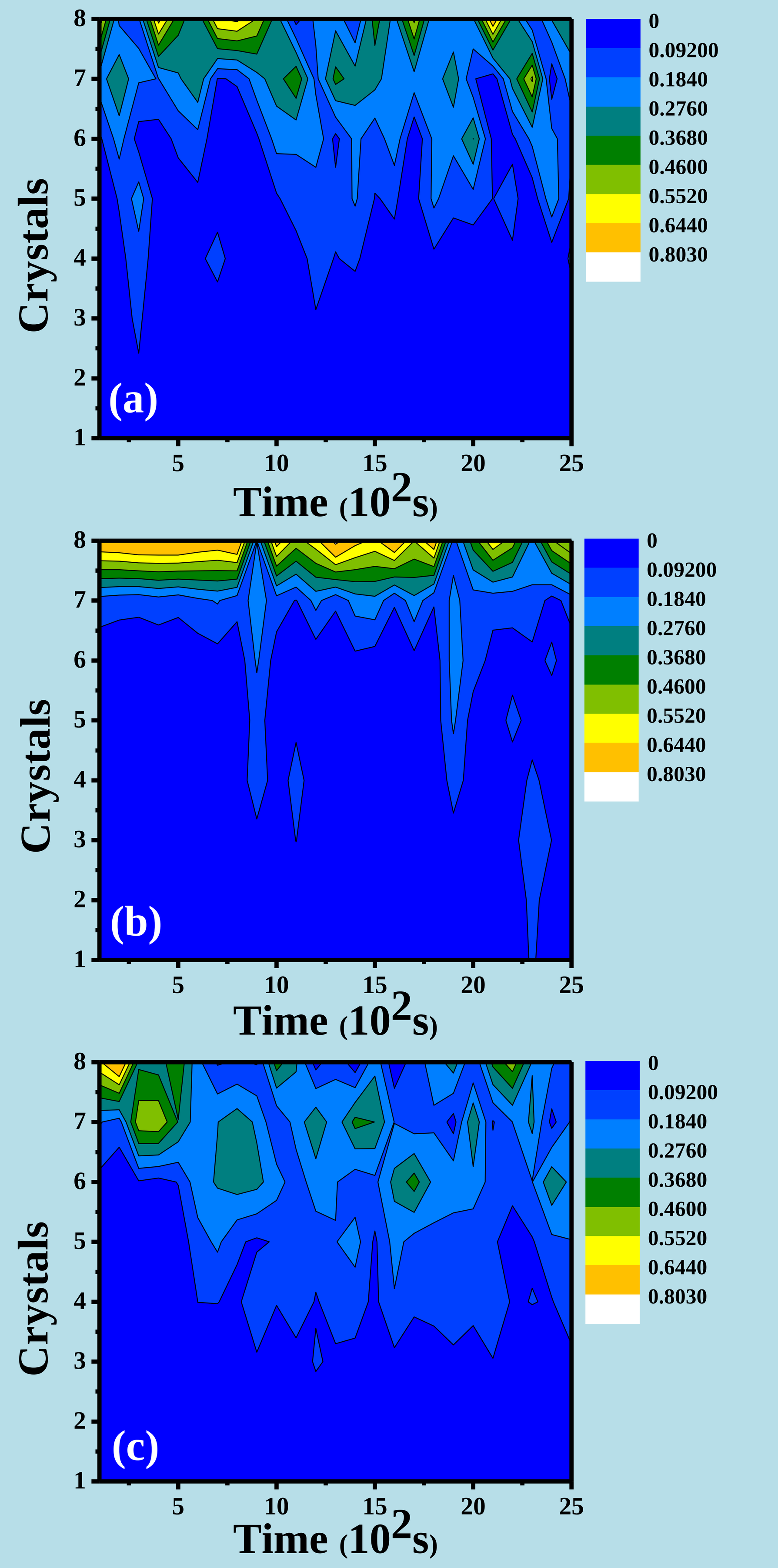

Figure 5 The EDP results of the Al–Ag samples as a function of dealloying time: (a) $Ag_{30}Al_{70}$, (b) $Ag_{35}Al_{65}$, and (c) $Ag_{40}Al_{60}$.

Conclusions

The effect of Al content on the nanoporous during the de-alloying of Al-Ag alloy is successfully investigated. It was observed that for different Al content of Ag-Al alloys, all Al and part of Ag_2Al are dealloyed. When the Al content is higher, for $Ag_{30}Al_{70}$ alloys, the mechanism of forming nanoporous is controlled by segregation Al, showing the bi-continuous nanoporous structure. When the Al content is lower, for $Ag_{40}Al_{60}$ alloys, the forming mechanism of nanoporous controlled by segregation Ag_2Al, existing the less nanoporous. So when the Al content to 65 at%, at the eutectic point, Al and Ag_2Al phase coexistence uniform, the typical 3D bi-continuous uniform nanoporous structure was successfully developed.