Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Synthesis, phase purification and magnetic characterization of the $(Cr_{1-x},Mn_x)_2AlC$ MAX-phase

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SUPPLEMENTARY INFORMATION

Table S1. EDX analysis results for the phases found on SEM images in Figure 1: $(Cr_{1-x}Mn_x)_2AlC$, Cr_5Al_8, Mn_3AlC. The standard deviation to each value, obtained via gathering point-by-point statistics, is given in brackets. The instrumental error is not included.

The detected phase	Average measured atomic content, at.%			
	Cr	Mn	Al	C
		***x* = 0**		
Cr_2AlC	49.53 (0.84)	-	24.26 (0.35)	26.2 (0.59)
Al_8Cr_5	35.92 (-)	-	64.08 (-)	-
		***x* = 0.05**		
$(Cr_{0.947}Mn_{0.053})_2AlC$	47.13 (0.46)	2.66 (0.42)	23.45 (0.05)	26.6 (0.38)
$Al_8(Cr,Mn)_5$	18.36 (1.77)	25.6 (1.24)	56.04 (0.72)	-
		***x* = 0.12**		
$(Cr_{0.878}Mn_{0.122})_2AlC$	43.98 (0.78)	6.14 (0.67)	23.68 (0.08)	26.18 (0.16)
$Al_8(Cr,Mn)_5$	36.39 (2.38)	9.19 (1.12)	54.42 (1.26)	-
		***x* = 0.16**		
$(Cr_{0.843}Mn_{0.157})_2AlC$	40.78 (0.36)	7.58 (0.27)	23.37 (0.2)	28.51 (0.94)
$(Mn,Cr)_3AlC$	23.38 (1.7)	32.41 (1.6)	21.16 (0.14)	23.06 (0.23)

Table S2. The amount of secondary phases from Rietveld refinements of the powder X-ray diffraction data of $(Cr_{1-x}Mn_x)_2AlC$ MAX-phase samples before chemical treatment.

The detected phase	Average measured atomic content, at.%			
	***x* = 0**	***x* = 0.05**	***x* = 0.12**	***x* = 0.16**
Cr_2AlC	98.3	97.1	89.3	75.3
Al_8Cr_5	1.7	2.9	6.2	-
Mn_3AlC	-	-	4.5	24.7

According to the refinement data, undoped Cr_2AlC (x = 0) as well as Cr_2AlC doped with 5at.% Mn (x = 0.05) are almost phase pure with a small amount of Al_8Cr_5 side phase. With increase of Mn doping level (x = 0.12 and x = 0.16) the formation of inverse perovskite Mn_3AlC is observed.

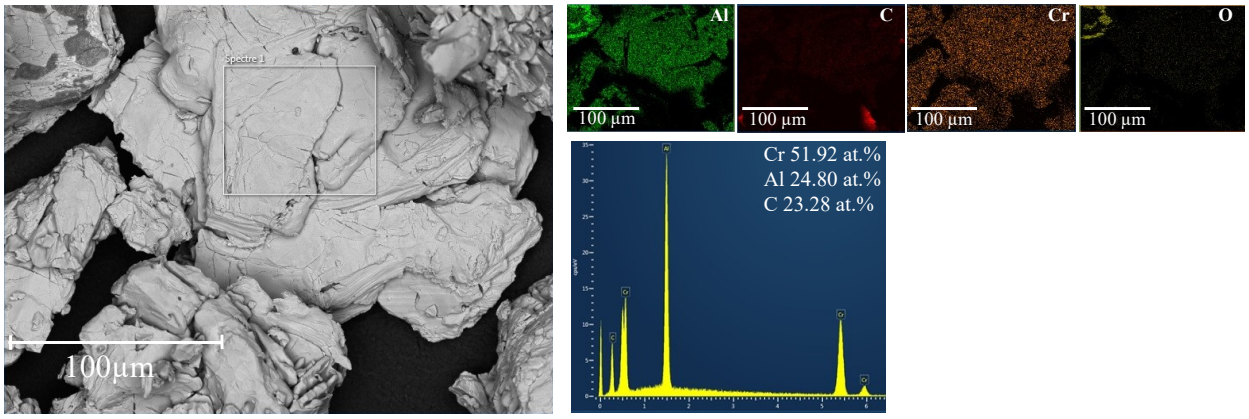

Figure S1. SEM image and EDX mapping of Cr_2AlC powder after chemical treatment.

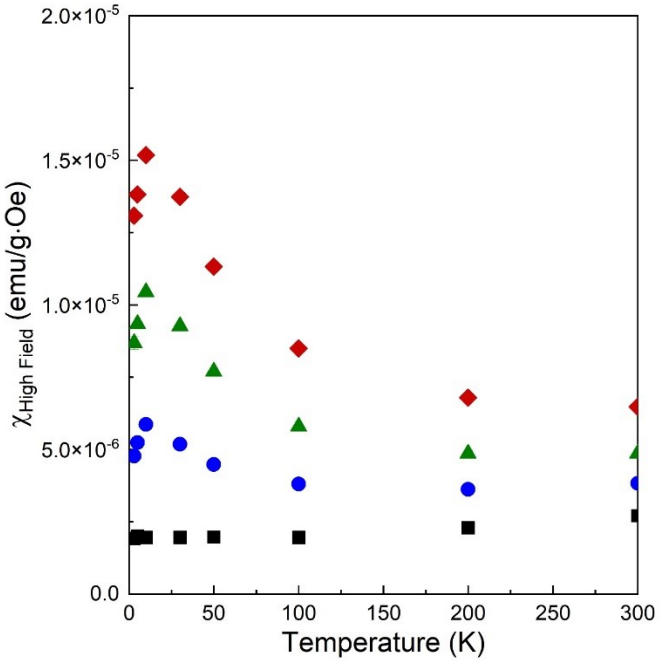

Figure S2. Magnetic high-field susceptibility $\chi_{High\ Field}$ vs T dependences for $(Cr_{1-x}Mn_x)_2AlC$ MAX-phase samples obtained from the hysteresis at various temperatures with x = 0 (black squares), 0.05 (blue squares), 0.12 (green squares) and 0.16 (red squares).