

Radiotracer diffusion in refractory high-entropy alloys

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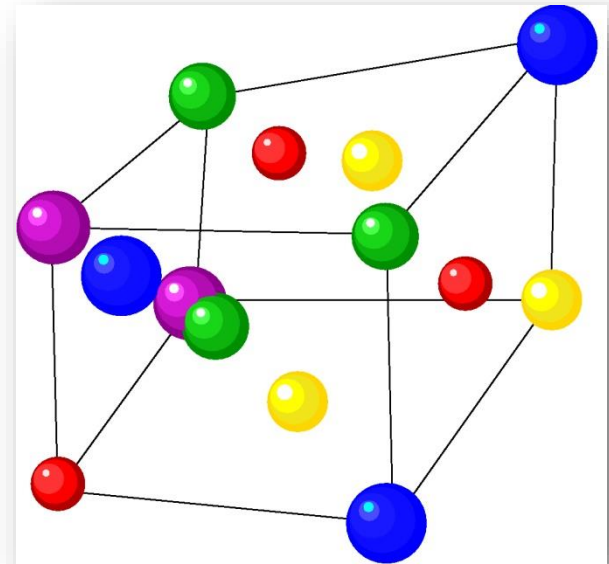
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High Entropy Alloys (HEAs)

Examples: CoCrFeMnNi & AlHfScTiZr

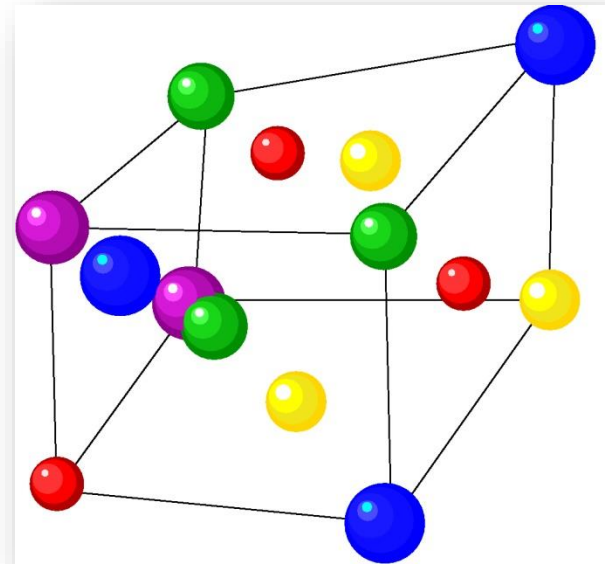
- > 5 metallic components
- ~ equal proportions
- disordered solid solutions
- single phase, no precipitates



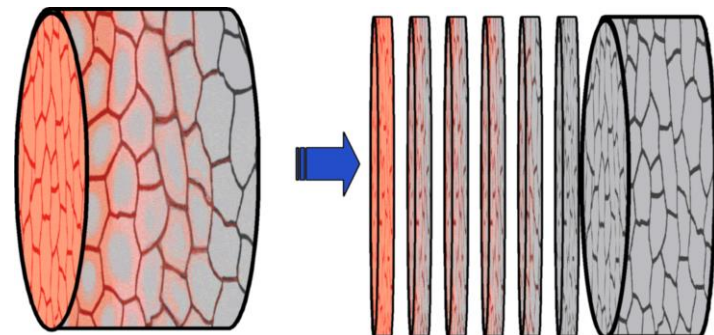
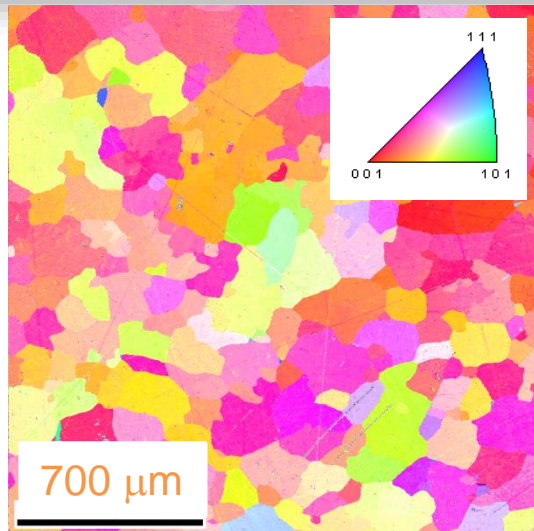
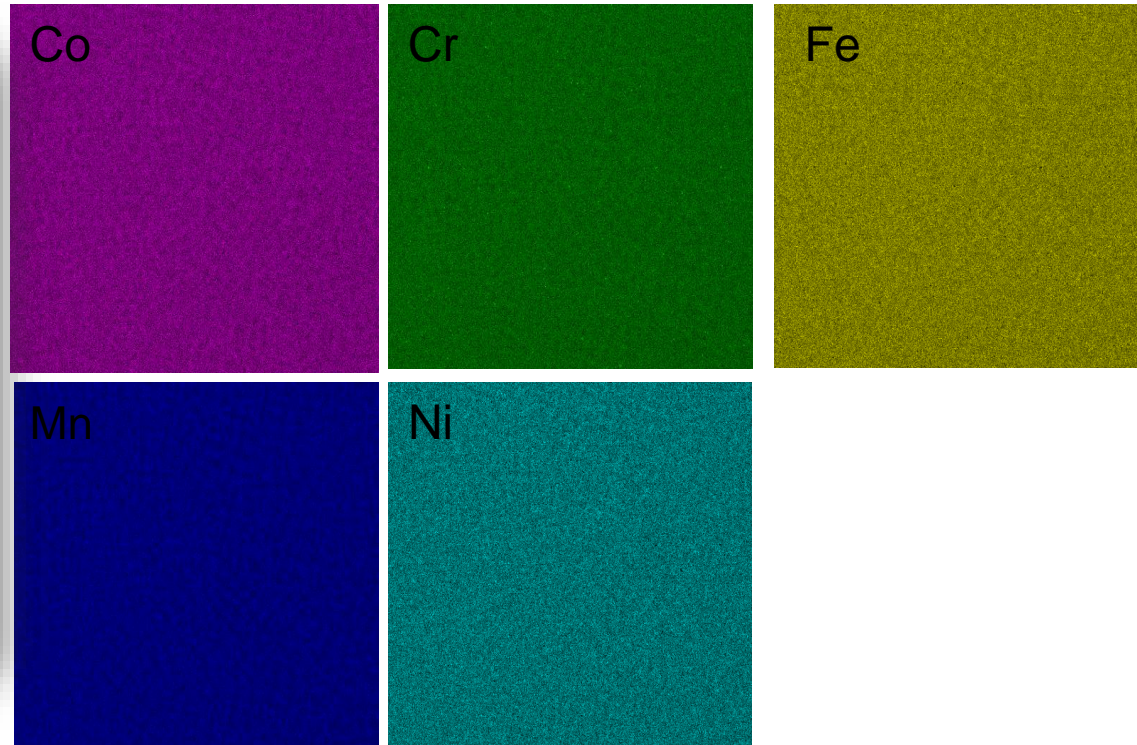
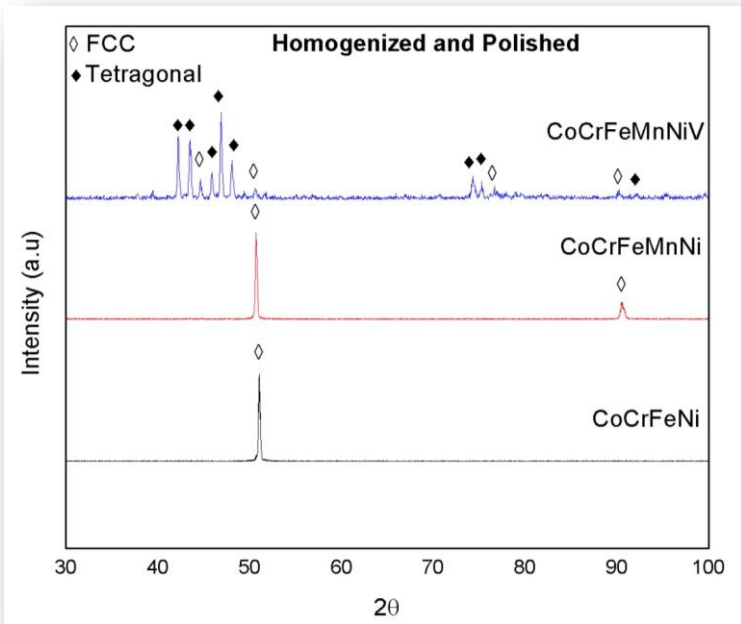
Core effects of High Entropy Alloys (HEAs)

Examples: CoCrFeMnNi & AlHfScTiZr

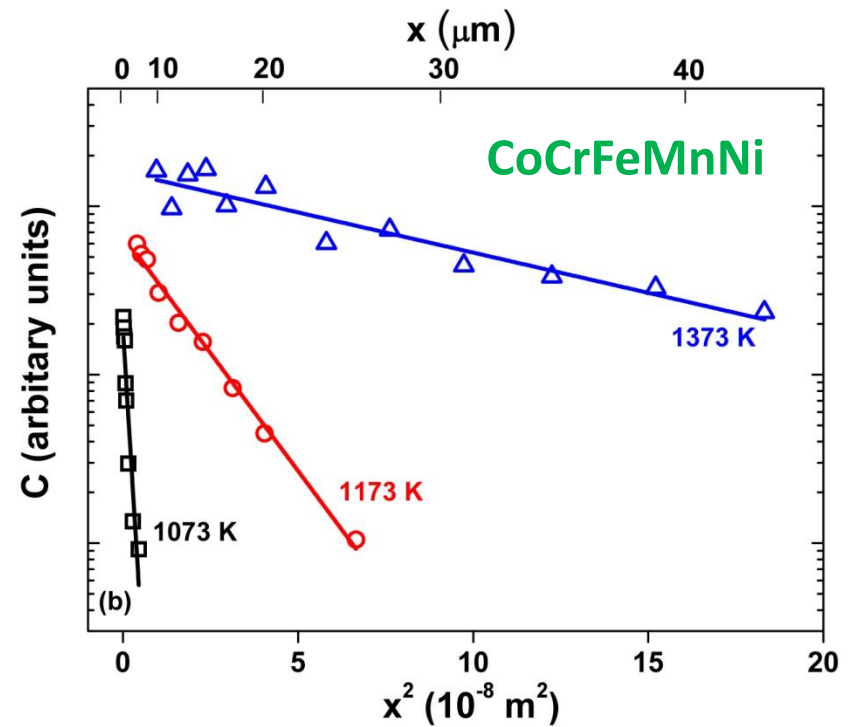
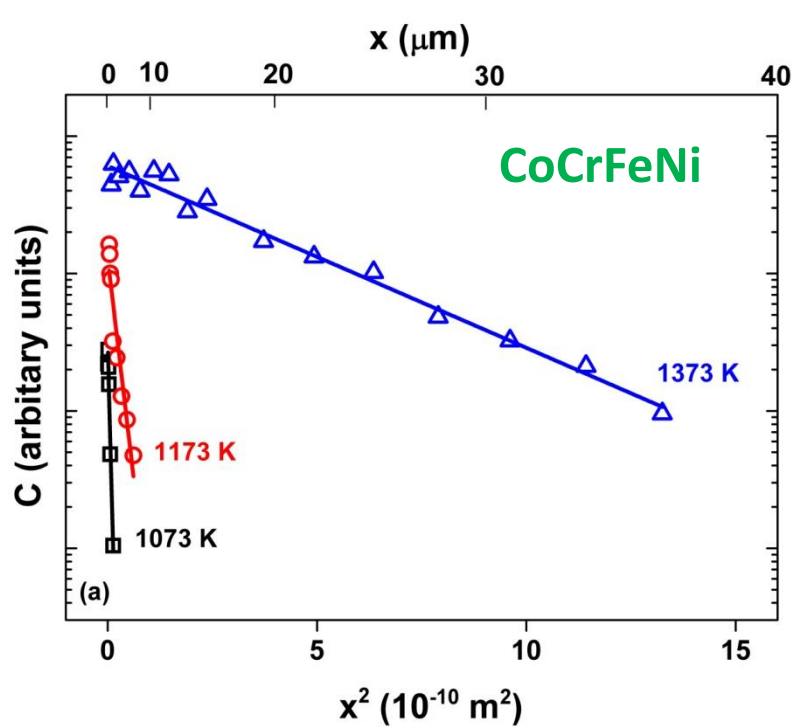
- high entropy
- severe lattice distortion
- "cocktail" effect
- sluggish diffusion ???



Preliminary work: Tracer diffusion in FeCoCrMnNi



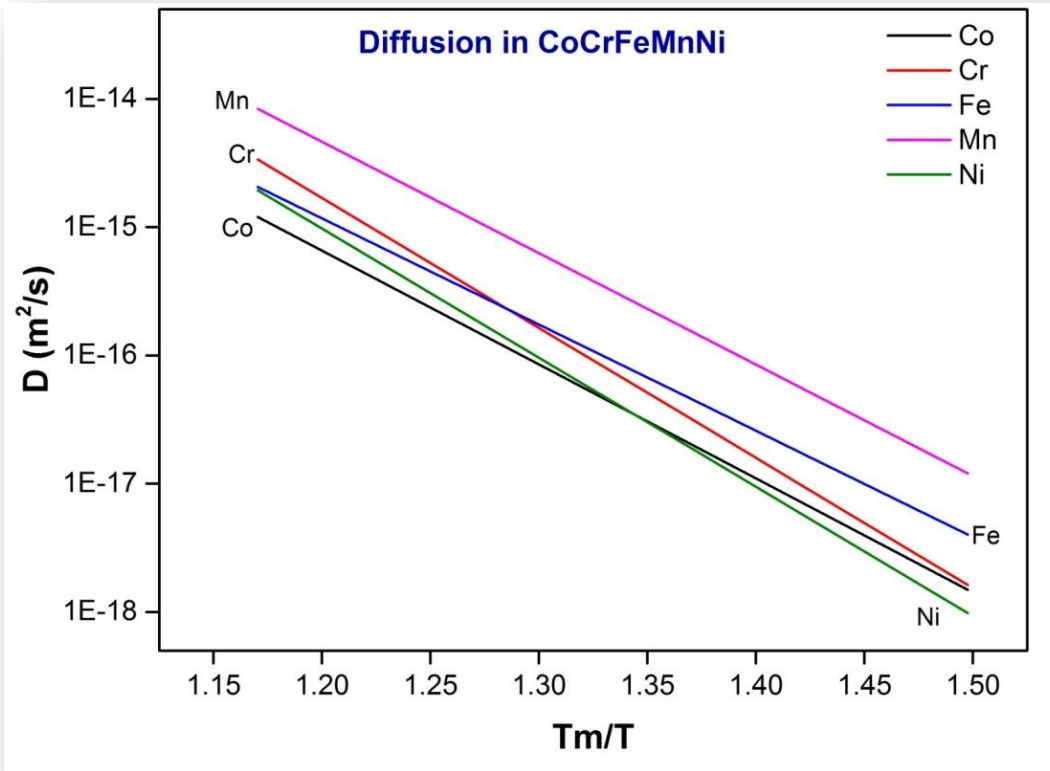
Preliminary work: ^{63}Ni profiles



$$\text{Gaussian profiles } \ln C = \ln C_0 - \frac{1}{4Dt} x^2$$

Vaidya M., Trubel S., Murty B.S., Wilde G., Divinski S.V.
Ni tracer diffusion in CoCrFeNi and CoCrFeMnNi high entropy alloys
JALCOM 688 (2016) 994-1001.

Preliminary work: Diffusion of different elements in CoCrFeMnNi



Tracer	Q (kJ/mol)	D0 (m ² /s)
Co	276	4.52E-5
Cr	312	2.46E-3
Fe	255	1.05E-5
Mn	267	1.25E-4
Ni	304	6.24E-4

Conclusion: diffusivities in the normal range for fcc metals !

System to study: Al-Hf-Sc-Ti-Zr HEA

Phase stability / ordering ($\alpha \rightarrow \alpha_2$)

Rogal, Bobrowski, Körmann, Stein, Grabowski, *submitted*

Goal of present project:

understand

phase stability, ordering and atom diffusion
in Al-Hf-Sc-Ti-Zr HEA

Diffusion of ^{46}Sc / ^{48}Sc and ^{173}Hf in AlHfScTiZr alloy:

Measurements at ISOLDE using ODC (available)

^{48}Sc (Ta target, implantation time about 1 hour, 43.7 h half time)

^{173}Hf (Ta target, implantation time ~30 min, 23.6 h half time)

^{46}Sc (Ti target, ~30 min, 83.8 d half time) – ideal for off-site measurements in Münster

These measurements will be combined with tracer experiments on ^{44}Ti & ^{95}Zr in Münster

⇒ Full diffusion database for the HEA will be produced!

⇒ In parallel, finite temperature DFT calculations (B. Grabowski, MPIE Düsseldorf) –
point defects, jump barriers

Refractory Al-Hf-Sc-Ti-Zr HEA

Effect of Cu on phase stability and decomposition
in Al-Hf-Sc-Ti-Zr HEA

Diffusion of ^{67}Cu in AlHfScTiZr-Cu_{0.5} alloy:

Measurements at ISOLDE using ODC (available)

^{67}Cu (UC_x target, implantation time ~30 min, 2.6 d half time)

Challenge:

^{29}Al (6.6 min half time) – still it is worth to try!

Summary of requested shifts: 11 shifts (3 years)

- share beamlines for ions
- we are not limited to the usage of the mentioned isotopes of Sc, Hf or Cu
- main requirements: acceptable half-life (at least 10 hours) and good yields for γ -rays