MM 33: Structural Materials

Time: Wednesday 10:15–11:30 Location: H26

MM 33.1 Wed 10:15 H26

Identifying isotropic auxetic modes in planar crystallographic frameworks — •Holger Mitschke[1], Gerd E. Schröder-Turk[1], Klaus Mecke[1], Patrick W. Fowler[2], and Simon D. Guest[3] — [1]Theoretische Physik, Univ. Erlangen — [2]Depart. Chemistry, Univ. Sheffield, UK — [3]Depart. Engineering, Univ. Cambridge, UK

Auxetic materials, i.e. with a negative Poisson's ratio, possess typical microstructures enabling deformations with either rotating or re-entrant elements. Here we idealise planar auxetic microstructures by frameworks of j joints connected by b rigid bars and restrict our study to frameworks with crystallographic symmetry. An observation is that known auxetic microstructures map to non-rigid (floppy) frameworks [1]. Under this assumption an analysis of the types of mechanisms w.r.t. auxeticity seems a promising approach to identify and understand auxetic materials in a simplified but often sufficient manner. The two-dimensional Calladine-Maxwell counting rule $m - s = 2j - b + 3$ gives the net mobility where m is the number of mechanisms and s the number of self-stresses. This rule can be extended by taking crystallographic symmetries into account [2] and has recently been extended to allow for periodicity [3]. In this talk the application to planar *hexagonal* and *square* groups is presented which gives sufficient counts of the number of symmetry-detectable isotropic auxetic mechanisms.

[1] Mitschke H. et.al. (2013), Proc. R. Soc. A, 469.
[2] Fowler, P.W. and Guest, S.D. (2000), Int. J. Solids. Struct, 37.
[3] Symmetry-extended counting rules for periodic frameworks, S.D. Guest and P.W. Fowler, to be published in Phil Trans Roy Soc A.

MM 33.2 Wed 10:30 H26

Atom Probe Tomography of Aluminum Lithium Based Alloy — •Muna Khushaim[1], Judith Leese[2], Torben Boll[1], Ferdinand Haider[2], and Talaat Al-Kassab[1] — [1]King Abdullah University of Science and Technology (KAUST), Division of Physical Sciences and Engineering, Thuwal 23955-6900. Saudi Arabia — [2]University of Augsburg, Inst. f. Physik, D-86159 Augsburg, Germany

Aluminum alloys exhibiting an improved weight/toughness ratio have been the primary materials for some structural components of aircraft applications. Such alloys can be strengthened through an imposed precipitation by a thermo-mechanical aging treatment. The primary strengthening precipitates $T_1(Al_2CuLi)$ and other metastable phases such as $\theta'(Al_2Cu)$ and $\delta'(Al_3Li)$ are expected to form at different stages of the post heat treatment of the alloy. Hence, an understanding of the distribution of alloying elements and of prestages of precipitation becomes imperative to understand the link between the microstructure and mechanical functionality of the respective alloy. In this study the Laser Assisted Wide Angle Atom Probe Tomography (LAWATAP) was applied to investigate the decomposed microstructure and the possible origins of hardening precipitates in a commercial Al-Li-Cu alloy (AA2195).

MM 33.3 Wed 10:45 H26

Characterization of the microstructure in Mg based alloy — •Arwa Kutbee[1], Talaat Al-Kassab[1], Xinhua Zhu[2], Zhiguo Liu[3], and Wenzheng Zhang[4] — [1]King Abdullah University of Science & Technology, Division of Physical Sciences and Engineering, Thuwal, 23955-6900, Kingdom of Saudi Arabia — [2]National Laboratory of Solid State Microstructures, School of Physics, Nanjing University, Nanjing 210093, China — [3]National Laboratory of Solid State Microstructures, Department of Materials Science and Engineering, Nanjing University, Nanjing 210093, China — [4]Laboratory of Advanced Materials, Department of Materials Science and Engineering, Tsinghua University, Beijing 100084, China

Magnesium based alloys are prospective materials for light weight application. Their creep and mechanical properties can be largely modified by precipitation hardening. In this paper, we report on the decomposition behavior of Mg-6.5Sn-3.3Zn-0.2Mn wt.% alloy using transmission electron microscopy (TEM) and Atom Probe Tomography (APT). Two techniques for TEM sample preparation have been employed: Focused ion beam (FIB) and ion beam milling. TEM lamella prepared by FIB at certain energy of the ion source might largely influence the crystalline structure in these alloys. Whereas, the ion beam milling method provided a preferable route to prepare transparent specimen for microstructural characterization. The TEM micrographs showed a lath shaped precipitates in the Mg matrix. APT composition analysis of the decomposed microstructure will be also presented and discussed.

MM 33.4 Wed 11:00 H26

Study of the phase transformation in SiC/AlN ceramic composite — •Naeem-Ur-Rehman Minhas[1], Jianye Wang[2], Finn Giuliani[2], Luc Vandeperre[2], and Talaat Al-Kassab[1] — [1]Physical Sciences and Engineering Division, King Abdullah University of Science & Technology, 4700, Thuwal, 23955-6900, Saudi Arabia — [2]Centre for Advanced Structural Ceramics, Department of Materials, Imperial College London, South Kensington Campus, London SW7 2AZ, UK

Silicon carbide (SiC) is used in various high temperature applications for its high hardness. However, the hardness of SiC drops with temperature because thermal activation of dislocations allows them to overcome the lattice resistance. Hence to enhance the high temperature properties of silicon carbide other strengthening mechanisms are needed. A tentative phase diagram of silicon carbide and aluminium nitride (AlN) points towards a region where perhaps decomposition occurs. Such phase separation should strengthen the resistance to dislocation glide or creep of SiC. The first aim is to produce a solid solution of SiC and AlN, and this will be followed by a heat treatment to induce the phase separation. X-ray diffraction results show the formation of a single phase with a simple hexagonal crystal structure confirming the formation of a solid solution. The decomposition path of the as prepared material as investigated with x-ray diffraction and transmission electron microscopy and Atom Probe Tomography will be presented and discussed within this contribution.

MM 33.5 Wed 11:15 H26

Stability of TCP phases in Co-based superalloys: Comparison of ab initio results with structure maps — •Jörg Kossmann, Thomas Hammerschmidt, and Ralf Drautz — ICAMS, Ruhr-Universität Bochum, Germany

Single crystal superalloys based on Ni are commonly used as turbine blades in industrial gas turbines for aero-engines and power plants. The observation of a stable $Co_3(Al,W)$ phase with $L1_2$ structure showed that single crystal alloys based on Co can also be fabricated. Such Co-based systems exhibit similar hardening mechanisms at a potentially higher melting point. Hence, we compare Co-based systems using high-throughput density functional theory calculations. In particular, we determine the heat of formation of the A15, C14, C15, C36, μ, χ and σ phases (with every possible stoichiometry) of the binary systems Co-W, Al-W, and Co-Al. We show that our DFT results are in line with a recently derived structure map based on experimental data. This work is part of the collaborative research center SFB/TR 103.