Article:

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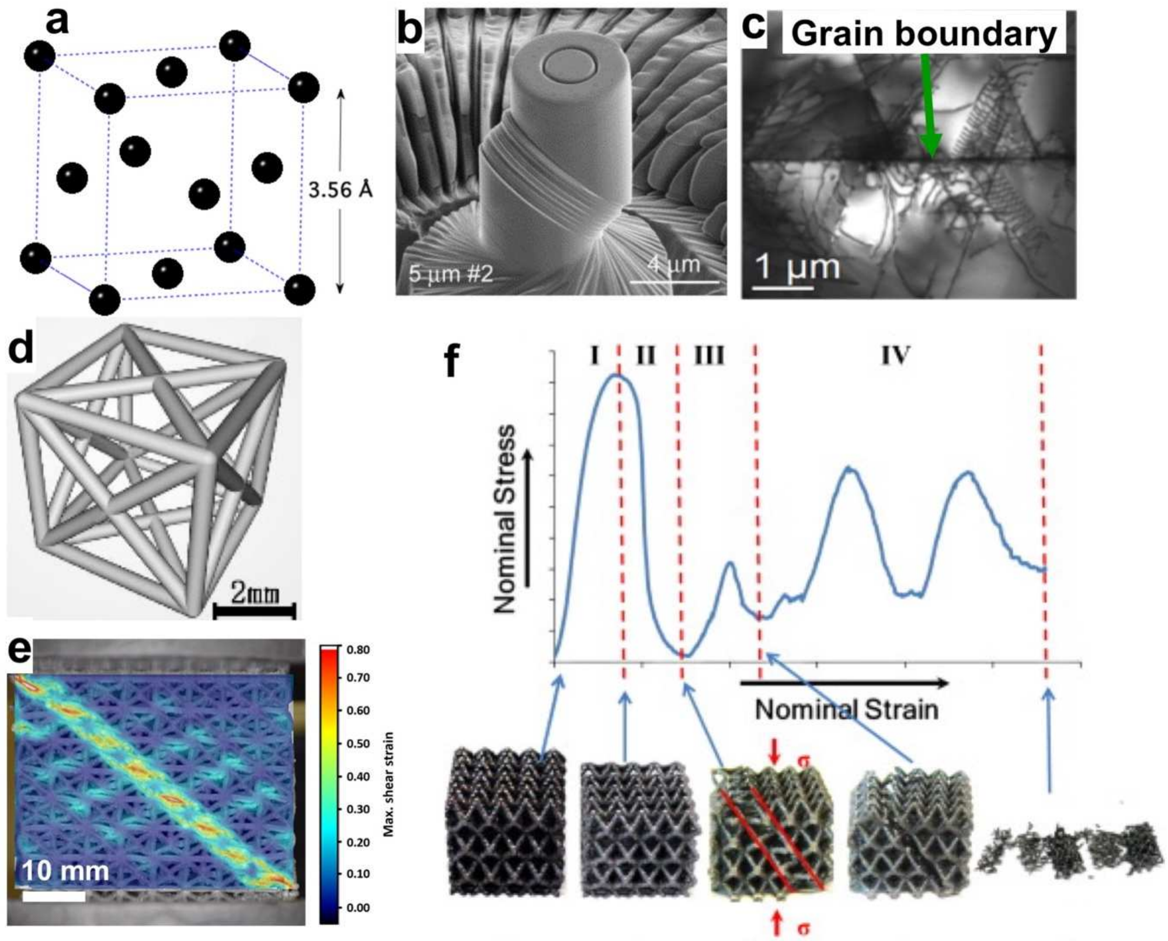

Figure 1: Lattice structures and deformation behaviour. (a) Face-centred-cubic (FCC) crystal lattice, (b) Single slips in a single crystal (re-used from [8] with permission from Elsevier), (c) Slips at grain boundary in a polycrystalline steel (re-used from[9] with permission from Elsevier), (d) Achitectured FCC lattice, (e) Single slip in a single oriented lattice, (f) Unstable behaviour of architectured metallic lattices (reused from [10] under the Creative Commons Attribution 4.0 International License).

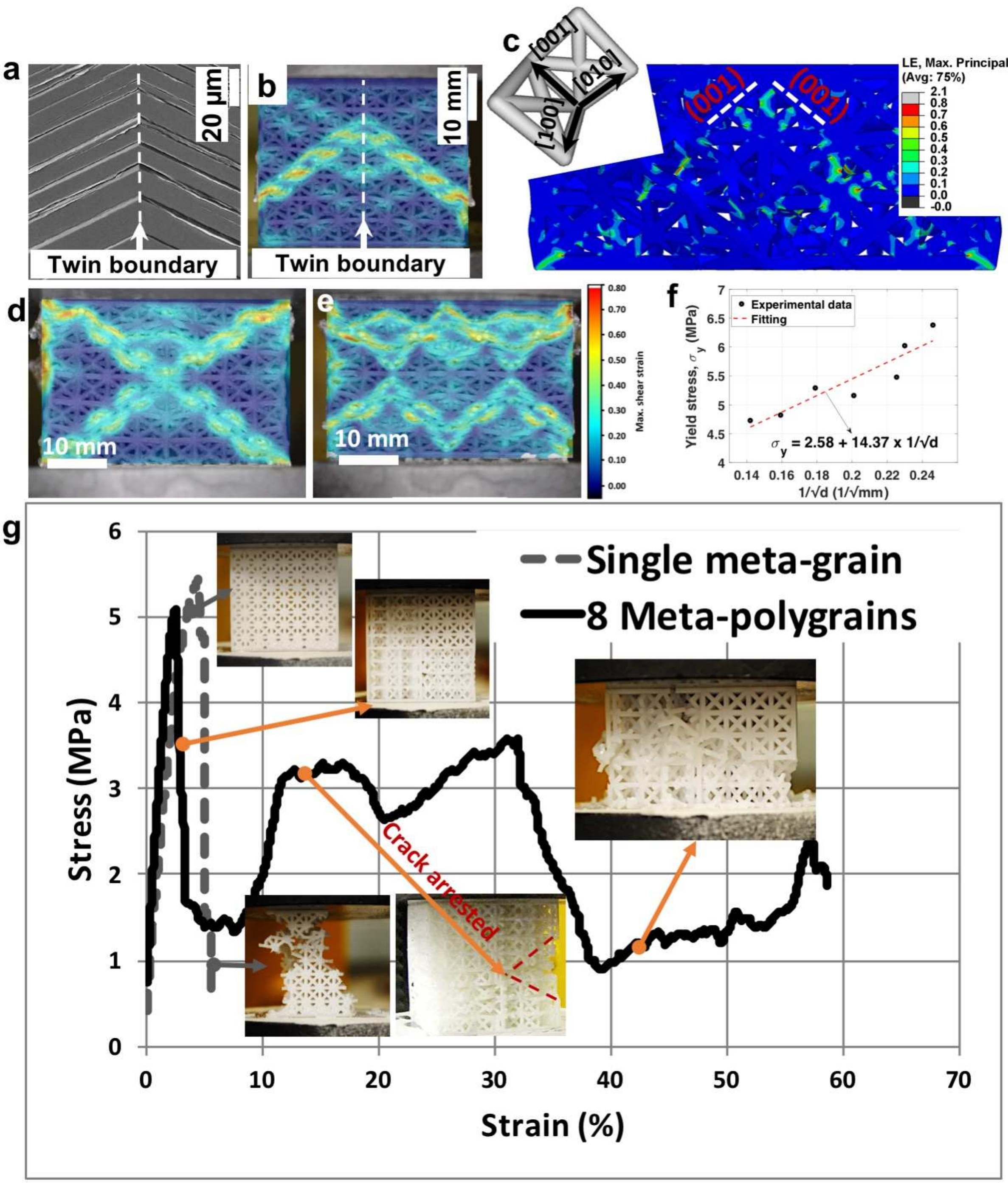

Figure 2: Roles of lattice orientation in the deformation behaviour of crystals and architectured lattices. (a) Twin bi-crystal (re-used from [27] with permission from Elsevier), Shear bands in meta-grain twins observed in experiment (b) and predicted by FEM (c) (Note: Cut sections shows the deformation of internal struts. The sections were formed thanks to two cutting planes that were parallel to {001} planes of FCC lattice), (d) – (e): Shear bands were controlled by orientation of meta-grains: (d) 8 meta-grains and (e) 16 meta-grains (note the nominal strain was of 30%). (f) Yield strength versus the size of meta-grains, (g) Boundaries between meta-grains effectively stops cracks in brittle lattices, leading to a drastic increase in toughness of architectured materials.

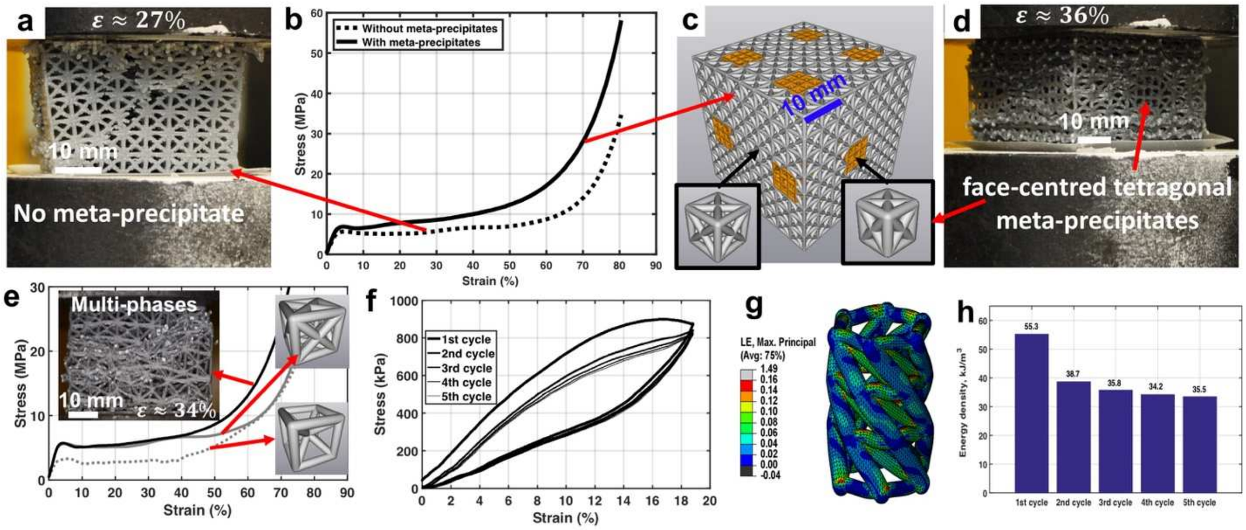

Figure 3: Precipitation and multiphase hardening in architectured materials. (a) A single oriented without meta-precipitates. (b) Constitutive stress-strain responses of architectured materials without meta-precipitates (a) and with meta-precipitates (c, d). (e) Mechanical behaviour of single phase versus multiphase architectured materials. (f) Pseudo-superelasticity of Kresling lattice, (g) FEM simulation shows the strain localisation and local buckling of struts, and (h) Energy per unit volume of the first five cycles.

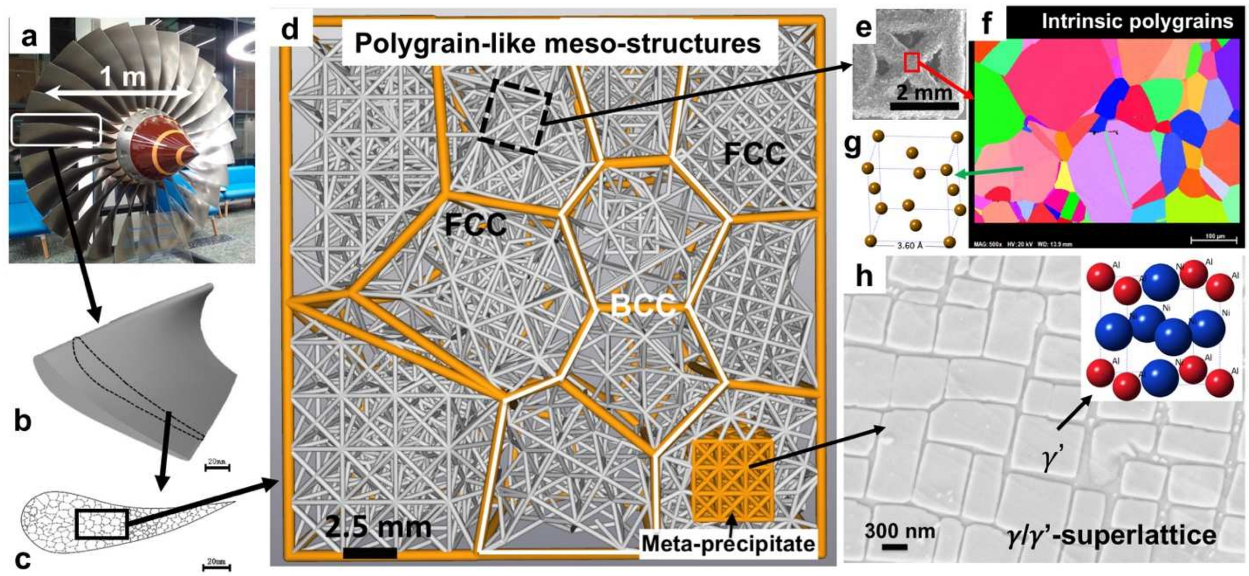

Figure 4: Lightweight and damage-tolerant architectured materials inspired by crystal microstructure. (a)-(d) Lightweight lattice component. (e)-(g) FCC fractal lattices from atomic up to cm scales, (h) γ/γ' scalable fractal super-lattices.