

Supplementary Materials

Computational Modelling and Simulation of Scaffolds for Bone Tissue Engineering

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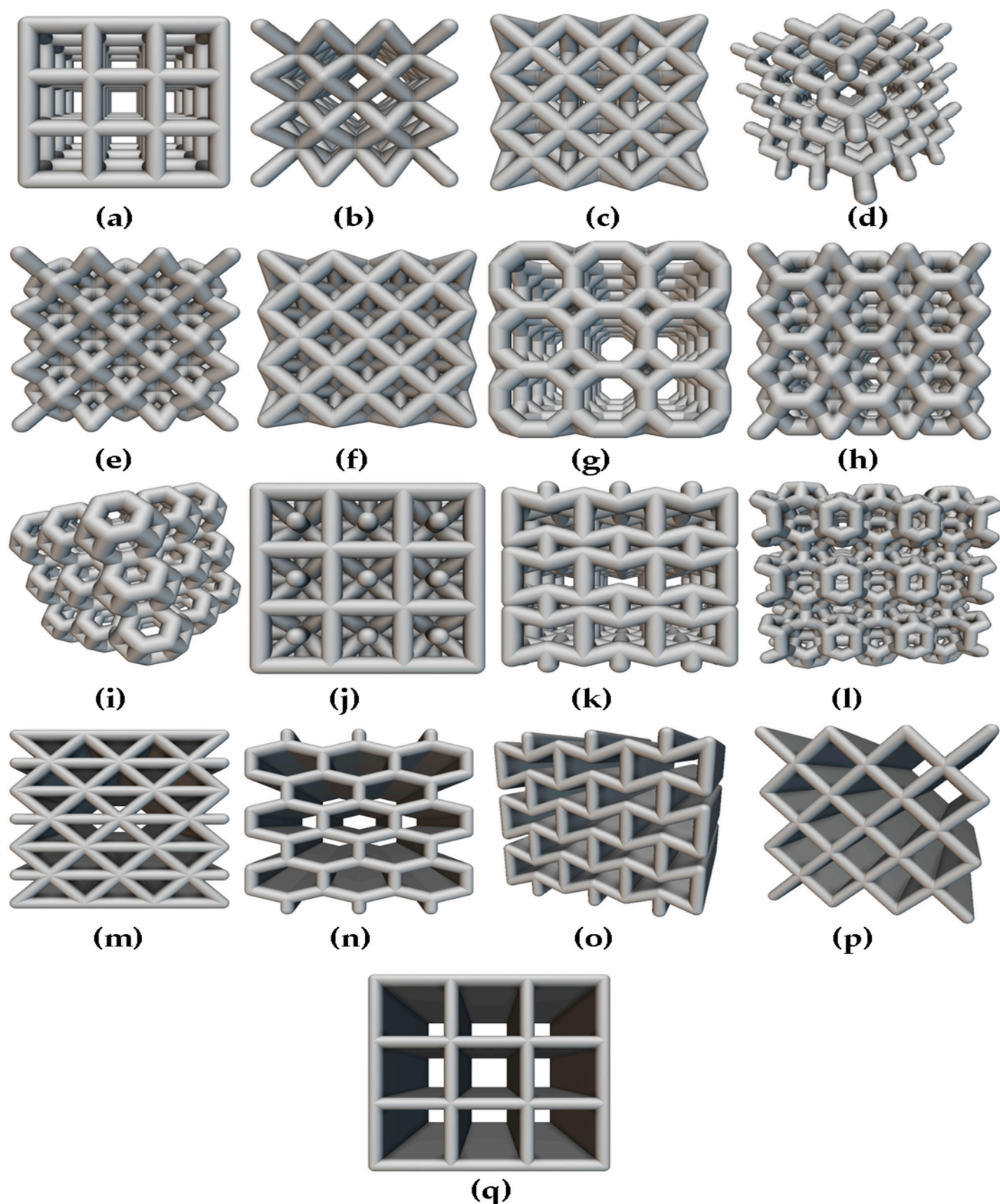


Figure S1. Non-Parametric designs of scaffolds : (a) Simple Cubic, (b) Body Centered Cubic (BCC), (c) Face Centered Cubic (FCC), (d) Diamond, (e) Fluorite, (f) Octet, (g) Truncated Cube, (h) Truncated Octahedron, (i) Kelvin Cell, (j) Iso Truss, (k) Re-entrant, (l) Weaire-Phelan, (m) Triangular HoneyComb, (n) Hexagonal HoneyComb, (o) Re-entrant HoneyComb, (p) Square HoneyComb Rotated, and (q) Square HoneyComb.

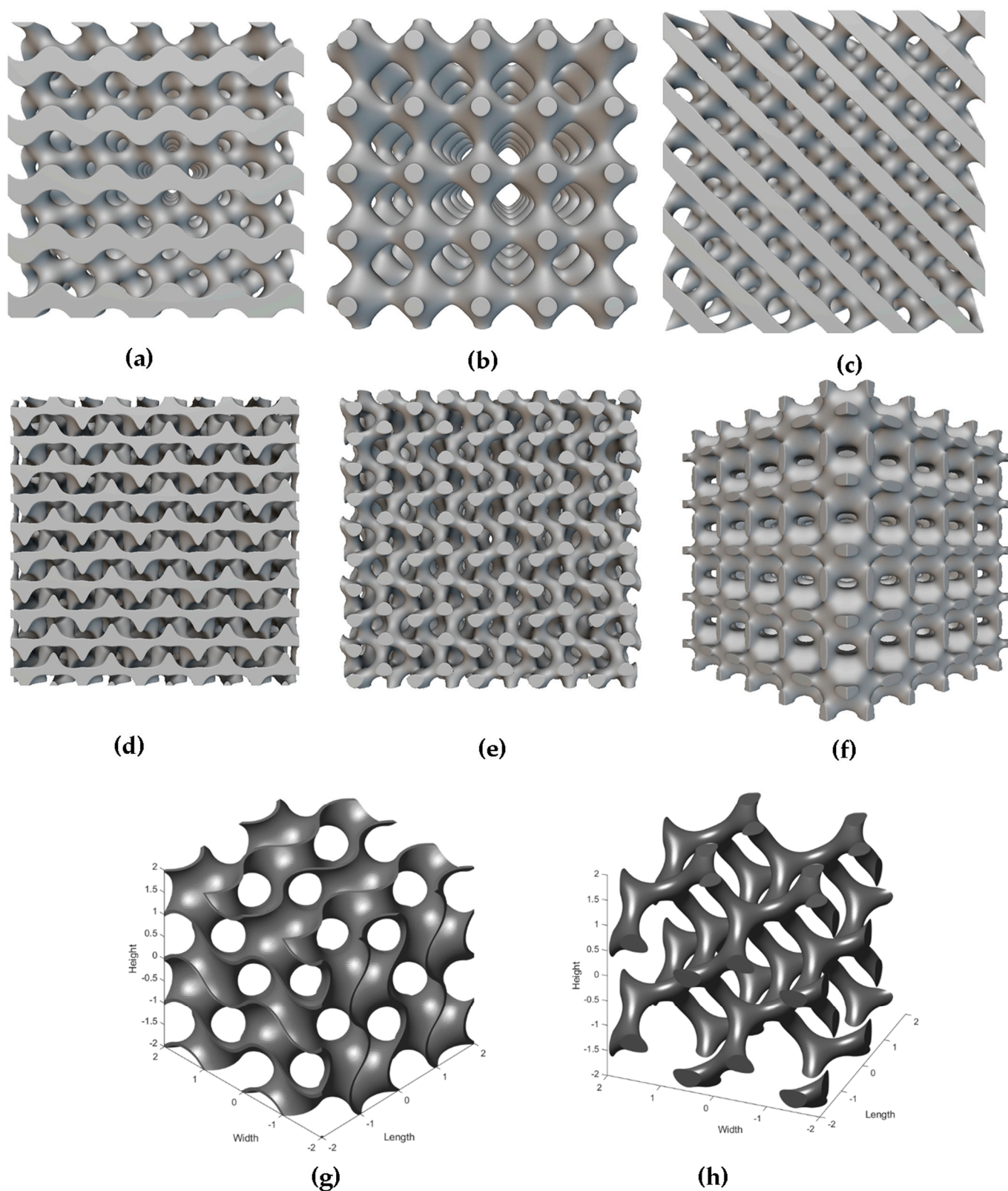


Figure S2. Parametric designs of scaffolds - TPMS : (a) Gyroid, (b) Schwarz, (c) Diamond, (d) Lidinoid, (e) Split P, (f) Neovius, (g) Gyroid sheet network and (h) Gyroid solid network.

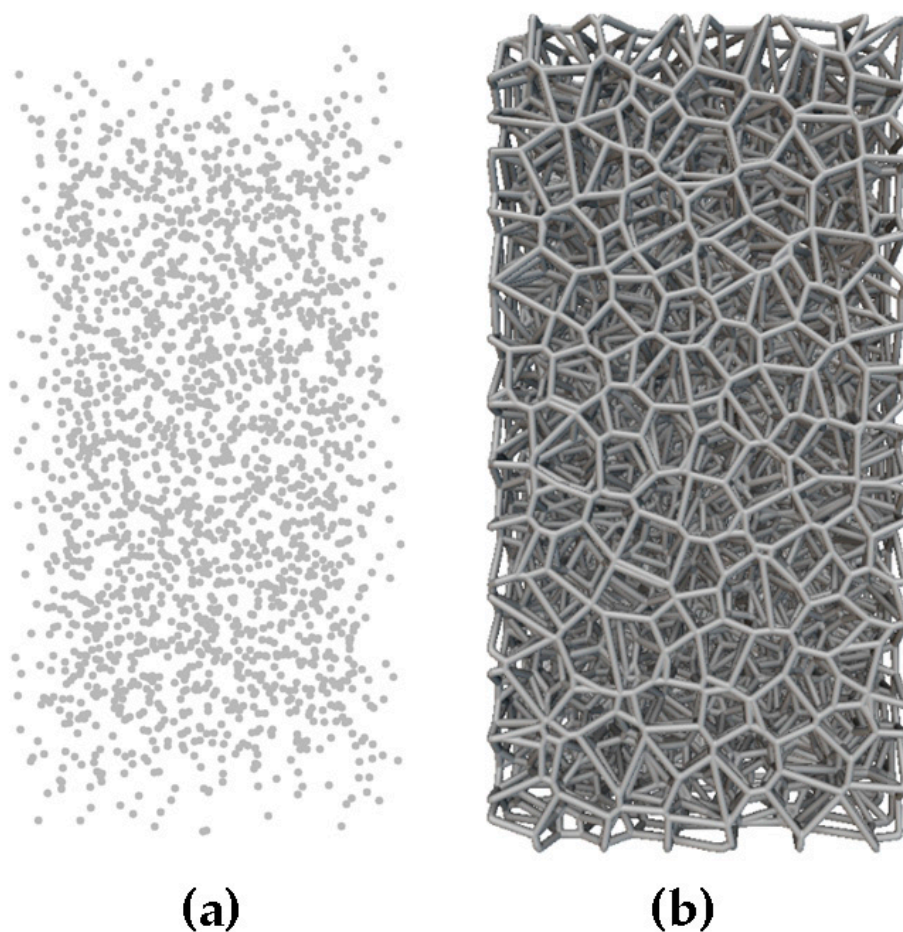


Figure S3. Parametric designs of scaffolds - Voronoi : (a) Random seed point within an implicit body and (b) The generated Voronoi lattice

Table S1. Software tools to design TPMS/Lattice-based scaffolds.

Software	Link
3DXpert	www.oqton.com/3dexpert/
Altair OptiStruct	www.altair.com/optistruct
ASLI (A Simple Lattice Infiller)	www.github.com/tpms-lattice/ASLI
<u>AutoDesk</u>	
Netfabb	www.autodesk.com/products/netfabb/
Within Medical	www.autodesk.com/products/within-medical/
Betatype	www.voxelmatters.directory/company/betatype/
CogniCAD	www.carbon3d.com/products/cognicad
Geomagic Design X	www.oqton.com/geomagic-designx/
MasMaker	www.github.com/CONMAD-CIDESIMX/MaSMaker
<u>Mathematica Based</u>	www.wolfram.com/mathematica/
RegionTPMS	www.github.com/metudust/RegionTPMS
<u>Matlab Based</u>	www.mathworks.com/products/matlab.html
FlattPack	www.github.com/ian27ax/FLatt_Pack_dist
gibbon Code	www.gibboncode.org/
Lattice Generator	www.mathworks.com/matlabcentral/fileexchange/48373-stl-lattice-generator
Lattice_Karak	www.github.com/SoftwareImpacts/SIMPAC-2022-125

matGeom	www.github.com/mattools/matGeom
Minimal Surfaces Visualisation Code	www.github.com/pttrsnv2/Minimal_Surfaces_Visualization_Code
MiniSurf	www.github.com/mengtingh/MiniSurf
MS Lattice	www.github.com/Alistairj43/TPMS-Designer
MS Lattice-PRO	www.oraibkhitan.com/mslattice/
scafSLICR	www.oraibkhitan.com/latticeit-scaffolds/
TPMS Designer	www.mathworks.com/matlabcentral/fileexchange/72856-scafslicr
TPMS Scaffold	www.github.com/Alistairj43/TPMS-Designer
Weighted Lattice Generator	www.mathworks.com/matlabcentral/fileexchange/99379-tpms-scaffold?s_tid=FX_rc2_behav
MathMod (K3DSurf)	www.mathworks.com/matlabcentral/fileexchange/106540-weighted-lattice-generator
Mimics Innovation Suite	www.sourceforge.net/projects/mathmod/
PTC Creo	www.materialise.com/en/healthcare/mimics-innovation-suite
nTopology	www.ptc.com/en/products/creo
Rhino Grasshopper Based	www.ntop.com
Axolotl	www.rhino3d.com/
IntraLattice	www.github.com/dbt-ethz/Axolotl/
Crystallon	www.intralattice.com/
Monolith	www.food4rhino.com/en/app/crystallon
Maths Models	www.food4rhino.com/en/app/monolith
Simpleware	www.myminifactory.com/object/3d-print-maths-models-triply-periodic-minimal-surface-structures-mega-pack-73944
Sulis Lattice	www.synopsys.com/simpleware.html
Surface Evolver	www.gen3d.com/sulis-lattice/
	www.kenbrakke.com/evolver/evolver.html

Table S2. List of FEM software

Software	Link
Abaqus/CAE	www.3ds.com/products-services/simulia/products/abacus/abaquscae/
ACE+ Suite	www.myesi.esi-group.com/downloads/software-downloads/ace-suite-2022.0
ADINA Structures	www.adina.com/adina-structures.shtml
Agros Suite	www.agros2d.org
Alibre	www.alibre.com/
Altair SimLab	www.altair.com/simlab
Altair SimSolid	www.altair.com/simsolid
AMPSol	www.ampstech.com/ampstech/Asp/Solvers.asp
Ansys Discovery	www.ansys.com/products/3d-design/ansys-discovery
Ansys Mechanical	www.ansys.com/products/structures/ansys-mechanical
Autodesk Inventor/Nastran	www.autodesk.com/solutions/simulation/finite-element-analysis
AutoFEM Analysis	www.autofem.com
CADRE Pro	www.cadreanalytic.com/cadrepro6.htm

CalculiX	www.calculix.de/
CAST3M	www-cast3m.cea.fr/index.php
Code_Aster	www.code-aster.org/
Comsol - Structural Mechanics Module	www.comsol.com/structural-mechanics-module
Creo Elements/Direct	www.ptc.com/en/products/creo/elements-direct
deal.II	www.dealii.org/
DUNE	www.dune-project.org/
Elmer FEM	www.elmerfem.org/
Europlexus	www-epx.cea.fr
FEA Tool Multiphysics	www.featool.com/
FEAP	www.projects.ce.berkeley.edu/feap/
FEBio	www.febio.org/
FEM-System MEANS	www.fem-infos.com/
FEniCSx	www.fenicsproject.org/
FlexPDE	www.pdesolutions.com
FreeCAD - FEM WorkBench	www.freecad.org/ , www.wiki.freecad.org/FEM_Workbench
Fusion 360	www.autodesk.com/products/fusion-360
GetDP	www.getdp.info
GetFEM	www.getfem.org/
GOMA	www.gomafem.com/
Hermes	www.hpfem.org
Impact	www.impact.sourceforge.net
KRATOS Multiphysics	www.github.com/KratosMultiphysics/Kratos
LISA - FEA	www.lisafea.com/
LUSAS Analyst	www.lusas.com/products/analyst.html
Mathematica FEM	www.wolfram.com/mathematica/ , www.reference.wolfram.com/language/FEMDocumentation/tutorial/FiniteElementOverview.html
MAT-fem	www.cimne.com/mat-fem/
Matlab FEA	www.mathworks.com/discovery/finite-element-analysis.html
Mecway FEA	www.mecway.com
midas NFX	www.nfx.midasuser.com/nfx
MFEM	www.mfem.org/
MOFEM	www.mofem.eng.gla.ac.uk/
MOOSE	www.mooseframework.inl.gov/
MORFEO	www.altair.com/morfeo
MSC Nastran / Patran	www.hexagon.com/products/product-groups/computer-aided-engineering-software/msc-nastran

NISA II	www.nisasoftware.com/software/nisa-mechanical/nisa-ii
Static/Dynamic	
NOGRID	www.nogrid.com/
nTopology	www.ntop.com/
OOFEM	www.oofem.org/
PERMAS	www.intes.de/k_permas
PrePoMax	www.prepomax.fs.um.si
Range	www.range-software.com/
QuickField	www.quickfield.com/
Siemens	www.solidedge.siemens.com/en/
SolidEdge	
Sim4Design	www.sim4design.com
Simcenter	www.plm.sw.siemens.com/en-US/simcenter/mechanical-simulation/femap/
Femap	
Simscale	
(Structural Mechanics)	www.simscale.com/product/structural-mechanics/
SimWise 4D	www.design-simulation.com/simwise4d
SfePy	www.sfepy.org
Solidworks FEA simulation	www.solidworks.com/product/solidworks-simulation
Solvias	www.solvias.eu
Strand7	www.strand7.com
StressCheck	www.esrd.com/products/stresscheck-professional/
SU²	www.su2code.github.io/
Visual FEA	www.visualfea.com/
WELSIM	www.welsim.com/
Z88/Z88 Aurora	www.en.z88.de/
Zebulon	www.zset-software.com/products/zebulon/

Table S3. List of CFD software

Software	Link
ACE+ Suite	www.myesi.esi-group.com/downloads/software-downloads/ace-suite-2021.0
ADINA CFD	www.adina.com/adina-cfd.shtml
AIRSHAPER	www.airshaper.com/
Altair CFD	www.altair.com/altair-cfd
Ansys Discovery	www.ansys.com/products/3d-design/ansys-discovery
Ansys Fluent/CFX	www.ansys.com/products/fluids
Agros Suite	www.agros2d.org
Autodesk CFD	www.autodesk.com/products/cfd/
Basilisk	www.basilisk.fr
Bramble	www.bramblecf.com
CADRE Flow	www.cadreanalytic.com/cadreflo.htm
CaNS	www.github.com/CaNS-World/CaNS

CAST3M	www-cast3m.cea.fr/index.php
CFDTool	www.cfdtool.com/
Channelflow	www.channelflow.ch
Comsol - CFD Module	www.comsol.com/cfd-module
Converge CFD	www.convergecd.com/
COOLFluiD	www.github.com/andrealani/COOLFluiD
Cradle CFD	www.cradle-cfd.com/
dicehub	www.dicehub.com/
Dolfyn	www.dolfyn.net/
Elmer	www.elmerfem.org
FEBio	www.febio.org/
FEniCSx	www.fenicsproject.org
Fidelity CFD	www.cadence.com/en_US/home/tools/system-analysis/computational-fluid-dynamics/fidelity.html
FlexPDE	www.pdesolutions.com
Flow - 3D	www.flow3d.com/products/flow-3d/
FlowVision	www.flowvisioncfd.com/
FLUBIO	www.flubiopetsc.github.io/flubiopetsc
FluidDyn	www.fluiddyn.netlify.app
FreeFEM	www.freefem.org/
FreeCAD - CfdOF Module (CFD OpenFoam)	www.github.com/jaheyns/CfdOF , www.freecad.org/
Hermes	www.hpfem.org
HiFlow³	www.hiflow3.org
IBAMR	www.ibamr.github.io
KRATOS Multiphysics	www.github.com/KratosMultiphysics/Kratos
LS - DYNA	www.ansys.com/products/structures/ansys-ls-dyna
MFC	www.mflowcode.github.io
MFIX	www.mfix.netl.doe.gov/products/mfix/
M-Star	www.mstarcfd.com
NEK	www.nek5000.mcs.anl.gov
NEKO	www.github.com/ExtremeFLOW/neko
NEKTAR++	www.nektar.info
NISA 3D-FLUID	www.nisasoftware.com/software/nisa-mechanical/3d-fluid
NOGRID	www.nogrid.com/
Omnis/LB	www.numeca.de/en/products-omnis-platform/
OneFLOW	www.github.com/eric2003/OneFLOW
OpenFOAM	www.openfoam.com/
OpenFVM	www.openfvm.sourceforge.net
OpenLB	www.openlb.net
Palabos (Parallel Lattice Boltzmann Solver)	www.gitlab.com/unigehpfs/palabos
PETSc-FEM	www.cimec.org.ar/foswiki/Main/Cimec/PETScFEM
POWERFLOW	www.3ds.com/products-services/simulia/products/powerflow/
Pyfr	www.pyfr.org
Rheolef	www.membres-ljk.imag.fr/Pierre.Saramito/rheolef
QuickerSIM CFD	www.old.quickersim.com/cfdtoolbox/

Range	www.range-software.com/ , www.github.com/Range-Software/range3
RhinoCFD	www.cham.co.uk/rhinoCFD.php
Salome CFD	www.salome-platform.org/
scFLOW	www.cradle-cfd.com/product/scflow.html
SC/Tetra	www.cradle-cfd.com/product/sctetra.html
SEAMPLEX	www.seamplex.com
SEMTEX	www.gitlab.com/semtex-base/semtex
Simcenter FLOEFD	www.plm.sw.siemens.com/en-US/simcenter/fluids-thermal-simulation/floefd/
Simcenter STAR-CCM+	www.plm.sw.siemens.com/en-US/simcenter/fluids-thermal-simulation/star-ccm/
SimFlow	www.sim-flow.com/
Simscale CFD	www.simscale.com/product/cfd/
SimWorks	www.idealsimulations.com/simworks-free-cfd-software/
Solidworks flow simulation	www.solidworks.com/product/solidworks-flow-simulation
Symscape	www.symscape.com/
SU²	www.su2code.github.io/
TCLB	www,github.com/CFD-GO/TCLB
Visual CFD	www.esi.com.au/software/visualcfd/
XFLOW	www.3ds.com/products-services/simulia/products/xflow/