

X-ray free electron laser experiments on fixed targets & high pressure samples

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The exploration of extreme states of matter – of high density, pressure, and temperature – has benefitted vastly from the availability of X-ray Free Electron Laser sources. However, XFEL experiments are often destructive, limiting the conditions and timescales accessible, as well as the types of samples and experiments. I discuss advances in laboratory experiments using high intensity XFEL sources exploring how fixed targets can be used in a variety of ways to explore very high pressures (millions of atmospheres) and temperatures (in electron Volt range). I discuss in particular use of Diamond Anvil Cells to impose static high pressure on samples during irradiation, to stabilize targets, improve the range of accessible conditions, and enable novel experimental solutions for high pressure problems. Applications include exploring material phases at the conditions of terrestrial and giant planet interiors, ultrafast chemical reactions, and damage mechanics in radiation-matter interactions. The experiments bridge an unusually wide range of timescales (femtoseconds to milliseconds), nonequilibrium and equilibrium conditions, and a variety of dynamic processes, requiring new experimental diagnostics, computational tools, and theoretical frameworks.

See website for more information: <https://www2.ph.ed.ac.uk/~rmcwilli/>