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Chemical Synthesis Under Extreme Pressures: Novel Condensed Matter Binary Compounds Containing Bismuth JAMES WALSH, Northwestern University, SAMANTHA CLARKE, Lawrence Livermore National Laboratory, KELLY POWDERLY, Princeton University, ALEXANDRA TAMERIUS, Northwestern University, YUE MENG, Argonne National Laboratory, STEVEN JACOBSEN, DANNA FREEDMAN, Northwestern University — Pressure is a fundamental thermodynamic variable that spans roughly 50 orders of magnitude throughout the universe, yet practically all of our chemical synthesis intuition is based upon results obtained near atmospheric conditions. At pressures on the order of millions of atmospheres, elemental properties that we consider fundamental become categorically altered. For example, atomic volumes drop sharply, valence orbital energies can fall below those of core orbitals, and electronegativities drift from their tabulated ambient pressure values. Even at relatively modest pressures of 10,000–100,000 atm, which are now readily accessible in the laboratory, these effects can lead to surprising new chemical bonding, structures, and properties, opening up a new frontier for chemical exploration. In this talk, I will show how we have harnessed pressure to exert thermodynamic control over the synthesis of novel binary bismuth intermetallic compounds that are impossible to synthesize using traditional methods. I will show how X-ray diffraction (both *in situ* and *ex situ*) can be used to solve the structures of the new phases that form, and I will give examples of high-pressure compounds that can be synthesized on the cubic millimeter scale to allow for bulk property measurements.

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