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Metallization of hydrogen and the essential differences between dynamic and static compression W.J. NELLIS, Harvard University — In 1935 Wigner and Huntington (WH) predicted that at density $D_{\mathrm{Thry}} = 0.62$ mole H/cm^3, "very low temperatures," and a pressure greater than 25 GPa, *bcc* H_2 undergoes an isostructural phase transition directly to H with an associated insulator-metal transition (IMT). In 1996 metallic fluid H was made under dynamic compression in a cross over from H_2 to H that completes at $D_{\mathrm{exp}} = 0.64$ mole H/cm^3, 140 GPa and T $\sim$ 2600 K. The Free-electron Fermi temperature $T_F = 220{,}000$ K and $T/T_F = 0.012 << 1$, as for ordinary metals at 300 K. To date solid metallic hydrogen has yet to be made at static pressures up to $\sim$360 GPa at T $\sim$ 300 K. This difference between electrical conductivity of H_2 compressed dynamically and statistically begs the question of why fluid H at 140 GPa and $\sim$3000 K becomes metallic at 0.64 mol H/cm^3, the density predicted by WH for their IMT at low T; whereas metallization of solid H_2 or H near 300 K is yet to be achieved experimentally at pressures up to $\sim$360 GPa? The answer is systematic differences induced by the rate of application of pressure in the two methods. Slow compression at $\sim$300 K strengthens solid H_2 by inducing intermolecular bonds, which impede dissociation, metallization and perhaps even thermal equilibrium. Fast dynamic compression of liquid H_2 up to $\sim$3000 K precludes formation of intermolecular H-H bonds, which permits fluid H_2 to weaken to dissociation and thus metallization at 140 GPa. Dynamic- and static-compression effects on materials will be compared in the context of how they effect metallization of hydrogen.

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