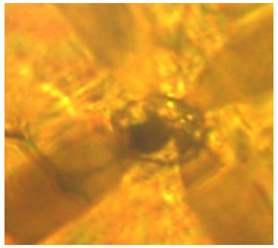
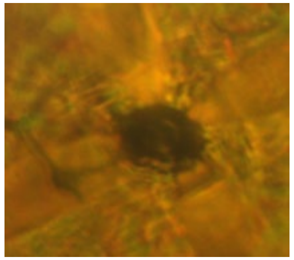
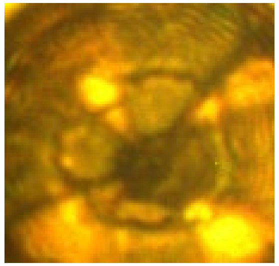
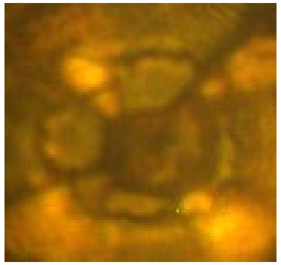
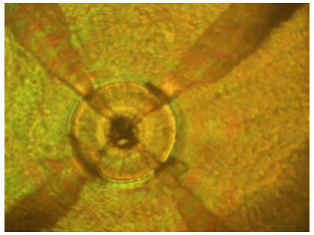
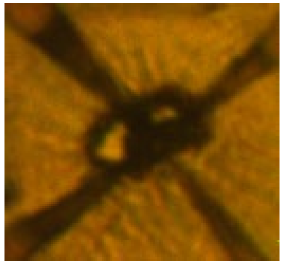
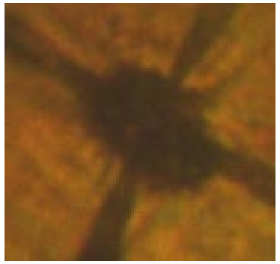
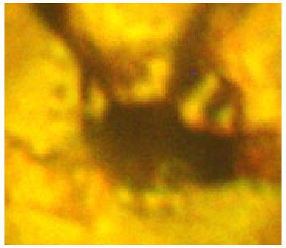
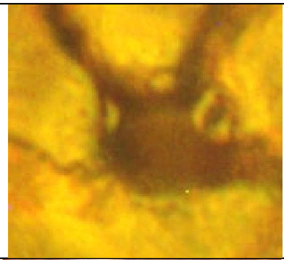
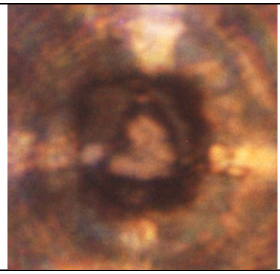
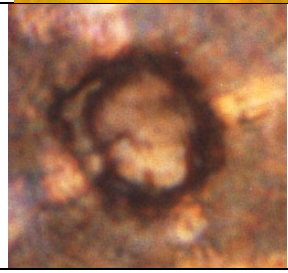
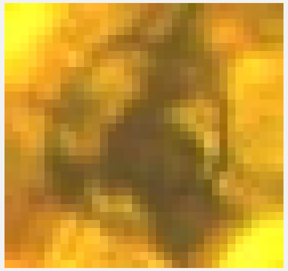
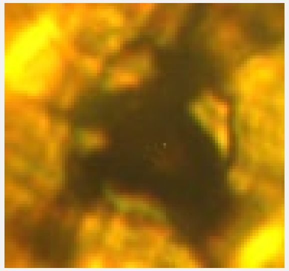
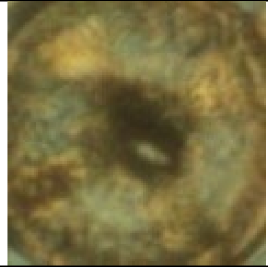
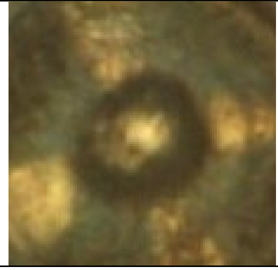
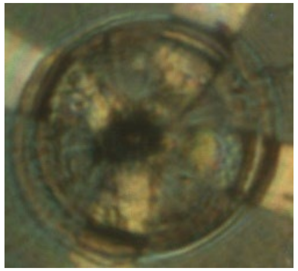
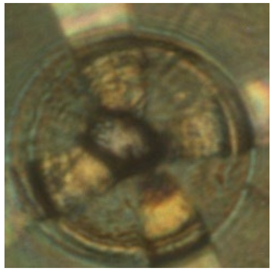
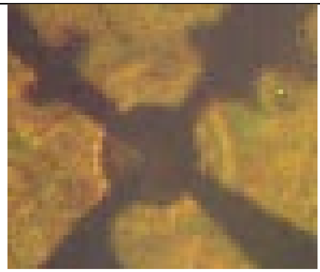
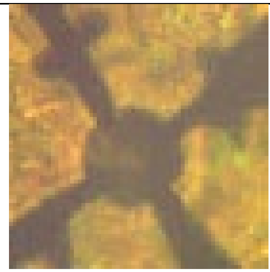
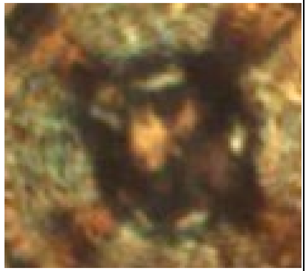
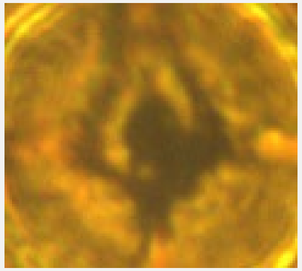
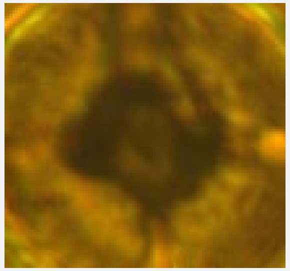
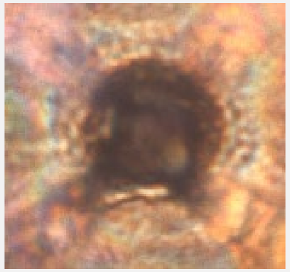
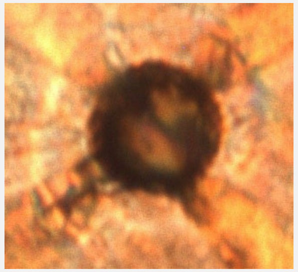
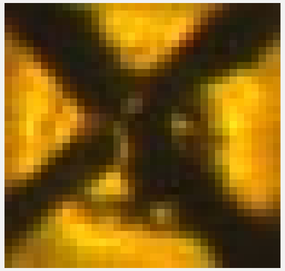
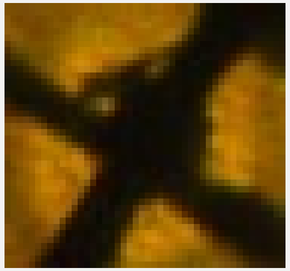
Table 1 of Samples

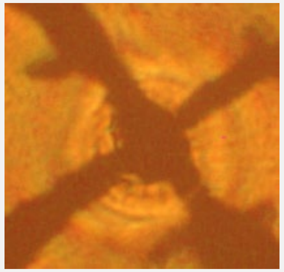
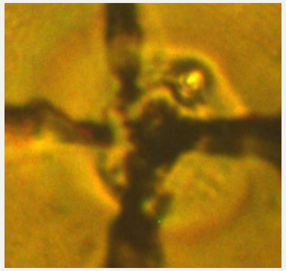
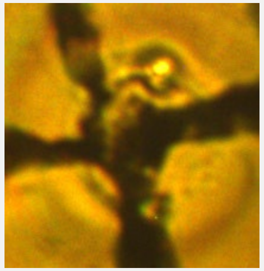
(*Deuterium experiments marked with grey background)

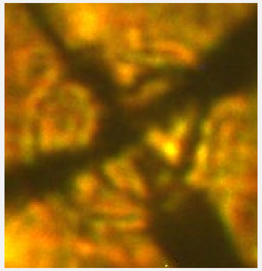
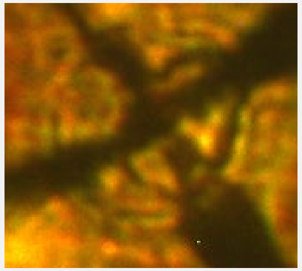
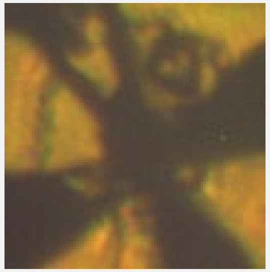
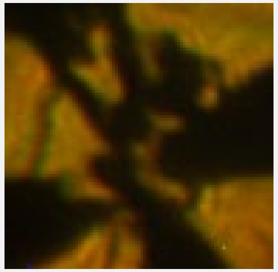
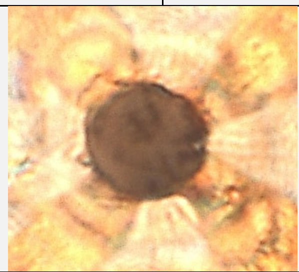
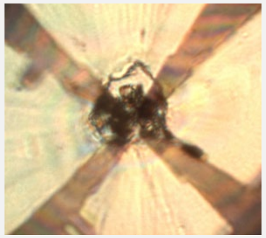
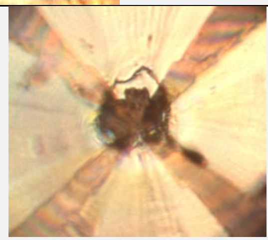
Sample	***Stoichiometry of superconducting phase***	***Synthesis conditions***	***Photo before and after heating***		***Electrical measurements***	***X-ray diffraction***
			Before	***After***		
1	LaH_{10} (expected from the value of T_c)	**La + H_2** **145 GPa laser heated** Mixture of La and excess of H_2 was compressed to 145 GPa. After the laser heating, H_2 vibron is seen around the sample			**P = 145 GPa, T_c ~ 244 K** **P = 151 GPa, T_c ~ 249 K** Resistance dropped to 0 Ω. Red and orange curves; and orange points, Fig. 1; Fig. ED 5	-----
2	LaH_{10}	**La + H_2** **137 GPa laser heated** Mixture of La and great excess of H_2 was pressurized to 137 GPa and then heated by laser			**P = 137 GPa, T_c ~ 243 K** Sharp superconductive transition to 0 Ω. Dark yellow curve and points in Fig. 1	***Fm-3m****,* dominant phase, *a*=5.1578(5) Å, *V*=137.21(4) Å^3; with impurity of *hcp (II):* ***$P6_3/mmc$ (LaH_{10})*** *a*=3.7525(7) Å, *c*=5.561(2) Å, *V*=67.81(2) Å^3; and minor impurity of *hcp (I):* ***$P6_3/mmc$ (LaH_{10})*** *a*=3.66 Å, *c*=5.95 Å, *V*=69.0 Å^3. Fig. 3a,b,d
3	LaH_{10}	**La + H_2** **150 GPa laser heated** La was pressurized in H_2 to 150 GPa and then heated by laser. All H_2 was absorbed by La			**P = 150 GPa, T_c ~ 249K** Blue curve and points in Fig. 1	***Fm-3m****,* dominant phase, *a*=5.1019(5) Å, *V*=132.80(4) Å^3; with minor impurities of *hcp (I):* ***$P6_3/mmc$ (LaH_{10})*** *a*=3.6226(8) Å, *c*=5.895(2) Å, *V*=66.99(3) Å^3; and ***Pm-3m ($LaH_{\sim12}$)*** *a*=3.2929(8) Å, *V*=35.70(3) Å^3. Fig. 3a,b,d

4	LaH_{10} (expected from the value of T_c)	**La + H_2** **150 GPa laser heated** Mixture of La and excess of H_2 was pressurized to 150 GPa and then heated by laser. After the chemical reaction H_2 is still present around the sample.			**P = 150 GPa, T_c ~ 246 K** Several pronounced superconductive steps with the highest T_c~246 K. The residual resistance is ~80 Ω at ~80 K. Green points in Fig. 1 (inset)	------
5	LaH_{10} (expected from the value of T_c)	**La + H_2** **145 GPa laser heated** Mixture of La and excess of H_2 was pressurized to 145 GPa and then heated by laser.			**P = 145 GPa, T_c ~ 251 K** Almost no pressure dependence of T_c in 145 – 172 GPa pressure range. Red points in Fig. 1(inset)	------
6	LaH_{10} (expected from the value of T_c)	**La + H_2** **145 GPa laser heated** Mixture of La and excess of H_2 was pressurized to 145 GPa and then heated by laser.			**P = 168 GPa, T_c ~ 249 K** T_c was measured in the 150-218 GPa pressure range Magenta points in Fig. 1 (inset).	------
7	LaH_{10} (expected from the value of T_c)	**LaH_3 + H_2(deficiency)** **141 GPa - no laser heating** LaH_3 was compressed in H_2 atmosphere at 141 GPa. No laser heating was used. H_2 was in deficiency.			**P = 141 GPa, T_c ~ 245 K** 2 weeks after the synthesis, superconductivity was measured with T_c ~245K. The superconductive step is broad, with R(200K)/R(245K) = 10%. R(300K)=1 Ω, R(75K) < 10^{-4} Ω. Black point in Fig. 1 (inset)	------
8	LaD_{11}	**La + D_2** **142 GPa laser heated** Mixture of La and excess of D_2 was compressed to 142 GPa. After the laser heating D_2 vibron is detected around the sample.			**P = 142 GPa, T_c ~ 140 K** Resistance dropped to nearly zero at ~126 K. Red point in the inset in Fig. ED 4b; Fig. ED 5	***P4/nmm***, dominant phase, *a*=3.7258(6) Å, c=5.0953(12) Å, V=70.73(2) $Å^3$; and impurity of *hcp (I):* ***$P6_3/mmc$ (LaD_{10})*** *a*=3.6389(11) Å, *c*=5.942(3) Å, *V*=68.14(4) $Å^3$. Fig. 3c,e

9	LaH_x, $x \geq 3$ (mostly LaH_3)	**La + H_2(deficiency)** **152 GPa laser heated** La in H_2 deficiency was pressurized to 152 GPa and then heated by laser.			**P = 152 GPa, $T_c \sim 108$ K**	Mostly LaH_3 phase *Fm-3m:* *a*=4.3646(5) Å, *V*=83.14(3) $Å^3$ and unidentified impurities. Black point in Fig. ED 1c
10	LaH_{x1}, $x_1 \geq 3$	**La + H_2(deficiency)** **178 GPa, before laser heating** La in H_2 deficiency was pressurized to 178 GPa at room temperature. No thermal treatment was applied.			**P = 178 GPa, $T_c \sim 70$ K** Several steps in R(T) with T_c of the first step at ~70 K. Under magnetic field of 5 T, all steps shifted to lower temperatures, including the onset of superconductivity which shifted to ~49 K. Black and red points in Fig. ED 2	------
	LaH_{x2}, $x_2 > x_1$ (traces of LaH_3)	**178 GPa, after laser heating** The same mixture (pressurized to 178 GPa) but with subsequent laser heatings. At every heating, the sample expanded by absorbing H_2 and got metallic luster of the final product.			**P = 178 GPa, $T_c \sim 112$ K** After the first laser heating, a new superconductive step at ~112 K was detected. Each succeeding laser heating led to gradual disappearance of the ~70 K step and growth of the ~112 K step. Blue and green points in Fig. ED 2; Fig. ED 5	Complex powder pattern with traces of *Fm-3m* LaH_3 phase *a*=4.313(2) Å, *V*=80.2(1) $Å^3$ Blue point in Fig. ED 1c; Fig. ED 1d,e
11	LaH_x, $x \geq 3$ (no traces of LaH_3)	**La + H_2(deficiency)** **150 GPa laser heated** Mixture of La in great deficiency of H_2 was pressurized to 150 GPa and then heated by laser.			**P = 150 GPa, $T_c \sim 70$ K** Sharp and narrow superconductive step with T_c~70 K. Magenta points in Fig. ED 2; Fig. ED 5	Unknown phase(s) with complex powder diffraction pattern. Green point in Fig. ED 1c

12	LaH_x	**$La + H_2$** **160 GPa laser heated** Mixture of La and excess of H_2 was pressurized to ~160 GPa and then heated by laser.			**P = 160 GPa, T_c ~ 210 K** **P = 150 GPa, T_c ~ 215 K** A sharp superconductive step with T_c~210 K at 160 GPa. By decreasing the pressure to 150 GPa T_c increased to 215K. Fig. ED 3; Fig. ED 5	------
13	LaD_x	**$La + D_2$** **139 GPa laser heated** Mixture of La and excess of D_2 was pressurized to 139 GPa at room temperature and then heated by laser.			**P = 139 GPa, T_c ~ 150 K** **P = 152 GPa, T_c ~ 165 K** One channel (resistance of ~1 kΩ) showed wide transition with T_c ~150 K at 139 GPa. T_c increases to ~165 K at increasing pressure to 152 GPa. Black, red and blue points in Fig. ED 4b, and black points in the inset; Fig. ED 5	------
14	LaD_x	**$LaD_3 + D_2$** **130 GPa, before laser heating** LaD_3 was compressed in excess D_2 atmosphere to 130 GPa.			**P = 130 GPa, T_c ~ 80 K** The onset of superconductivity is at ~80 K. R(300K)=0.2 Ω. R(60K) < 10^{-4} Ω. Fig. ED 5	------
	LaD_{10}	**131 GPa, after laser heating** **D_2 was in deficiency**			The sample became semitransparent, and its R(300K) increased to 6 Ω. R(T) demonstrated an anomaly at T_c ~113 K, which can be attributed to superconductivity.	almost pure *hcp (II)* ***$P6_3/mmc$ (LaD_{10})*** *a*=3.7460(5) Å, *c*=5.5849(17) Å, *V*=67.87(2) $Å^3$
15	LaD_{11}	**$La + D_2$** **154 GPa laser heated** Mixture of La and excess of D_2 was pressurized to 154 GPa at room temperature and then heated by laser.			**P = 163 GPa, T_c ~ 168 K** Green point in the insert of Fig. ED 4b	***P4/nmm ($LaD_{\sim11}$),*** *a*=3.6767(9) Å, c=5.0327(19) Å, V=68.03(3) $Å^3$; with minor impurities (possibly *hcps)*

16	LaD_{10-11}	**La + D_2** **146 GPa laser heated** Mixture of La and excess of D_2 was pressurized to 146 GPa at room temperature and then heated by laser.			**P = 161 GPa, T_c ~ 168 K** Blue point in the insert of Fig. ED 4b	A mixture of *hcp (II):* ***P6₃/mmc ($LaD_{\sim 10}$)*** *a*=3.6920(9) Å, *c*=5.459(4) Å, *V*=64.44(4) $Å^3$; and ***P4/nmm ($LaD_{\sim 11}$)***: *a*=3.6969(5) Å, c=5.040(1) Å, V=68.88(2) $Å^3$; *with minor impurity of hcp (I)* ***$P6_3/mmc$ ($LaD_{\sim 10}$)*** *a*=3.622(2) Å, *c*=5.825(5) Å, *V*=66.20(6) $Å^3$.
17	LaD_{10}	**La + D_2** **120 GPa laser heated** Mixture of La and D_2 was pressurized to 120 GPa at room temperature and then heated by laser. No conductivity after laser heating. Pressure was increased to 152 GPa, and SC with T_c~180 K was measured.			**Before heating at 152 GPa:** **P = 152 GPa, T_c ~ 180 K** **After heating at 152 GPa in two steps:** **P = 147 GPa, T_c ~ 187 K** **P = 147 GPa, T_c ~ 160 K**	**Before heating at 152GPa:** a mixture of ***Fm-3m (LaD_{10})*** *a*=5.136(5) Å, *V*=135.4(4) $Å^3$; *hcp (I):* ***$P6_3/mmc$ (LaD_{10})*** *a*=3.639(4) Å, *c*=5.886(6) Å, *V*=67.5(1) $Å^3$; and *hcp (II):* ***$P6_3/mmc$ (LaD_{10})*** *a*=3.761(3) Å, *c*=5.483(8) Å, *V*=67.2(1) $Å^3$; and unidentified impurities. **After heating at 152 GPa:** a mixture of ***P4/nmm (LaD_{11})***, *a*=3.750(2) Å, c=4.971(5) Å, V=69.88(8) $Å^3$; *hcp (I):* ***$P6_3/mmc$ (LaD_{10})*** *a*=3.6519(13) Å, *c*=5.927(2) Å, *V*=68.46(4) $Å^3$; *and hcp (II)* ***$P6_3/mmc$ (LaD_{10})*** *a*=3.772(2) Å, *c*=5.496(5) Å, *V*=67.71(7) $Å^3$ and the same unidentified impurities.

18	$LaD_{\sim10}$	**La + D_2** **147 GPa laser heated** Mixture of La and excess of D_2 was pressurized to 147 GPa at room temperature and then heated by laser at low power (no glowing).			**P = 147 GPa : $T_c \sim$ 160 K** **After 1 month:** **P = 153 GPa : $T_c \sim$ 180 K**	A mixture of *hcp (II):* ***P6₃/mmc ($LaD_{\sim10}$)*** *a*=3.708(3) Å, *c*=5.484(6) Å, *V*=65.32(9) $Å^3$; and ***Fm-3m (LaD_{10})*** *a*=5.06 Å, *V*=129.6 $Å^3$; and minor unidentified impurity
19	LaD_{10-11}	**La + D_2** **109 GPa laser heated** **127GPa laser heated** **140 GPa laser heated** **154 GPa laser heated** La+D_2 was compressed to 109 GPa. After laser heating a new Raman peak appeared at 3110 cm^{-1}. After pressurizing to 127 GPa, X-ray diffraction was measured. After laser heating at 140 GPa some parts of the sample became transparent. The new Raman peak from the sample persists up to 154 GPa (although its frequency decreased to 3104 cm^{-1}).	140 GPa, before heating 	140 GPa, after heating 	The 4th electrode was not in contact with the sample. Resistance between other electrodes was R~1.5 – 2.5 kΩ	At 127 GPa dominant phase is ***Fm-3m (LaD_{11})*** *a*=5.2671(8) Å, *V*=146.12(6) $Å^3$; impurity of *hcp (II):* ***P6₃/mmc (LaD_{10})*** *a*=3.7549(11) Å, *c*=5.598(2) Å, *V*=68.35(4) $Å^3$; and traces of *hcp (I):* ***P6₃/mmc (LaD_{10})*** *a*=3.66 Å, *c*=6.04 Å, *V*=70.3 $Å^3$; and unidentified phase(s)
20	LaD_3	**LaD_3 + D_2** **111-123 GPa no laser heating** LaD_3 was compressed in D_2 atmosphere to 111-123 GPa. D_2 was in deficiency.			**P ~ 111-123 GPa:** **$T_c \sim$ 68 K** R(300K)=1Ω, R(55K) < 10^{-4} Ω.	Nearly pure *Cmcm*-LaD_3, *a*=2.90 Å *b*=6.77 Å *c*=4.67 Å, *V*=91.7 $Å^3$
21	LaH_{12}	**LaH_3 + H_2** **153 GPa laser heated** LaH_3 was compressed in H_2 atmosphere to 153 GPa and then heated by laser. H_2 was in a great excess.			After heating the sample became semi-transparent, R > 1 MΩ	After heating at 159 GPa: mostly distorted primitive simple cubic *Pm-3m*-LaH_{12} with *a*=3.30 Å, *V*=35,9 $Å^3$ and minor impurity of *Fm-3m*-LaH_{10} with *a*=5.10 Å, *V*=132,6 $Å^3$