Amorphous sulphur or Sγ exists in two forms, one soluble in carbon bisulphide, the other insoluble. Milk of sulphur (see above), obtained by decomposing a polysulphide with an acid, contains both forms. The insoluble variety may also be obtained by decomposing sulphur chloride with water and by other re­actions. It gradually transforms itself into rhombic sulphur.

The colloidal sulphur, Sδ, described by Debus as a product of the interaction of sulphuretted hydrogen and sulphur dioxide in aqueous solution, is regarded by Spring *(Rec. trav. chinι.,* 1906, 25, p. 253) as a hydrate of the formula S8∙H2O. The “ blue sulphur,” described by Orloff, has been investigated by Paternò and Mazzucchelli (*Abs*. *Journ. Chem. Soc.,* 1907, ii. 451).

*Molten Sulphur.—*Several interesting phenomena are witnessed when sulphur is heated above its melting point. The solid melts to a pale yellow liquid which on continued heating grad­ually darkens and becomes more viscous, the maximum vis­cosity occurring at 180°, the product being dark red in colour. This change is associated with a change in the spectrum (N. Lockyer). On continuing the heating, the viscosity diminishes while the colour remains the same. If the viscous variety be rapidly cooled, or the more highly heated mass be poured into water, an elastic substance is obtained, termed plastic sulphur. This substance, however, on standing becomes brittle. The character of molten sulphur has been mainly elucidated by the researches of A. Smith and his collaborators. Smith *(Abs. Journ. Chem. Soc.,* 1907, ii. 20, 451, 757) regards molten sulphur as a mixture of two isomers Sλ and Sµ in dynamic equilibrium, Sλ being light in colour and mobile, and Sμ dark and viscous. At low temperatures Sλ predominates, but as the temperature is raised Sµ increases; the transformation, however, is retarded by some gases, *e.g.* sulphur dioxide and hydrochloric acid, and accelerated by others, *e.g.* ammonia. The solid derived from Sλ is crystalline and soluble in carhon bisulphide, that from Sμ is amorphous and insoluble. As to the formation of precipitated sulphur, Smith considers that the element first separates in the liquid Sµ condition, which is transformed into Sλ and finally into Sα; the insoluble (in carbon bisulphide) forms arise when little of the Sµ has been transformed; whilst the soluble consist mainly of Sα. Similar views are adopted by II. Erdmann *(Ann.,* 1908, 362, p. 133), but he regards Sµ as the polymer S3, analogous to ozone O3; Smith, however, regards Sµ as S8.

*Compounds.*

Sulphuretted hydrogen, H2S, a compound first examined by C. Scheele, may be obtained by heating sulphur in a current of hydrogen, combination taking place between 200° C. and 358° C., and being complete at the latter temperature, dissociation taking place above this temperature (Μ. Bodenstein, *Zeit. phys. Chem.,* 1899, 29, p. 315); by heating some metallic sulphides in a current of hydrogen; by the action of acids on various metallic sulphides (ferrous sulphide and dilute sulphuric acid being most generally employed); by the action of sulphur on heated paraffin wax or vaseline, or by heating a solution of magnesium sulphydrate. It is also produced during the putrefaction of organic substances containing sulphur and is found among the products obtained in the destructive distillation of coal. To obtain pure sulphuretted hydrogen the method generally adopted consists in decomposing precipitated antimony sulphide with concentrated hydrochloric acid. As an alternative, H. Moissan *(Comp, rend.,* 1903, 137, p. 363) condenses the gas by means of liquid air and fractionates the product.

Sulphuretted hydrogen is a colourless gas possessing an extremely offensive odour. It acts as a strong poison. It burns with a pale blue flame, forming sulphur dioxide and water. It is moderately soluble in water, the solution possessing a faintly acid reaction. This solution is not very stable, since on exposure to air it slowly oxidizes and becomes turbid owing to the gradual precipitation of sulphur. The gas is much more soluble in alcohol. It forms a hydrate of composition H2S∙7H2O. (De Forcrand, *Compt. rend.,* 1888, 106, p. 1357.) The gas may be liquefied by a pressure of about 17 atmospheres, the liquid so obtained boiling at -61∙8° C. ; and by further cooling it yields a solid, the melting point of which is given by various observers as —82° to —86° C. (see Ladenburg, *Ber.,* 1900, 33, p∙ 637). It is decomposed by the halogens, with liberation of sulphur. Concentrated sulphuric acid also decomposes it: H2SO4+H2S=2H2O+SO2+S. It combines with many metals to form sulphides, and also decomposes many metallic salts with consequent production of sulphides, a property which renders it extremely useful in chemical analysis. It is frequently used as a reducing agent: in acid solutions it reduces ferric to ferrous salts, arsenates to arsenites, permanganates to manganous salts, &c., whilst in alkaline solution it converts many organic nitro compounds into the corresponding amino derivatives. Oxidizing agents rapidly attack sulphuretted hydrogen, the primary products of the reaction being water and sulphur.

By the action of dilute hydrochloric acid on metallic polysulphides, an oily product is obtained which C. L. Berthollet considered to be H3S5. L. Thénard, on the other hand, favoured the formula H2S2. It was also examined by W. Ramsay *(Journ. Chem. Soc.,* 1874, 12∙ p. 857). Hofmann, who obtained it by saturating an alcoholic solution of ammonium sulphide with sulphur and mixing the product with an alcoholic solution of strychnine, considered the resulting product to be H2S3; while P. Sabatier by fractionating the crude product in vacuo obtained an oil which boiled between 6o° and 85° C. and possessed the composition H4S5.

Several halogen compounds of sulphur are known, the most stable of which is sulphur fluoride, SF6, which was first prepared by H. Moissan and Lebeau *(Compt. rend.,* 1900, 130, p. 865) by fractionally distilling the product formed in the direct action of fluorine on sulphur. It is tasteless, colourless and odourless gas, which is exceedingly stable and inert. It may be condensed and yields a solid which melts at —55° C. Sulphuretted hydrogen decomposes it with formation of hydrofluoric acid and liberation of sulphur. Sulphur chloride, S2Cl2, is obtained as a by-product in the manufac­ture of carbon tetrachloride from carbon bisulphide and chlorine, and may also be prepared on the small scale by distilling sulphur in a chlorine gas, or by the action of sulphur on sulphuryl chloride in the presence of aluminium chloride (O. Ruff). It is an amber-coloured, fuming liquid possessing a very unpleasant irritating smell. It boils at 139°C. and is solid at —80° C. It is soluble in carbon bisulphide and in benzene. It is gradually decomposed by water: 2S2Cl2 + 3H2O = 4HCl + 2S + H2S2O3, the thiosulphuric acid pro­duced in the primary reaction gradually decomposing into water, sulphur and sulphur dioxide. Sulphur chloride dissolves sulphur with great readiness and is consequently used largely for vulcanizing rubber; it also dissolves chlorine. The chloride SCl2 according to the investigations of O. Ruff and Fischer *(Ber.,* 1903, 36, p. 418) did not appear to exist, but E. Beckmann *(Zeit, phys. Chem.,* 1909, 42, p. 1839) obtained it by distilling the product of the interaction of chlorine and S2Cl2 at low pressures. The tetrachloride, SCl4, is formed by saturating S2Cl2 with chlorine at —22o C. (Michaelis, *Ann.,* 1873, 170, p. 1). It is a yellowish-brown liquid which dissoci­ates rapidly with rise of temperature. On cooling it solidifies to a crystalline mass which fuses at —8o° C. (Ruff, ibid.). Water decomposes it violently with formation of hydrochloric and sul­phurous acids. Sulphur bromide, S2Br2, is a dark red liquid which boils with decomposition at about 2oo° C. The products obtained by the action of iodine on sulphur are probably mixtures, although E. Mclvor *(Chem. News,* 1902*,* 86, p. 5) obtained a substance of composition S3I2 (which in all probability is a chemical individual) as a reddish-coloured powder by the action of sulphuretted hydrogen on a solution of iodine trichloride.

Four oxides of sulphur are known, namely sulphur dioxide, SO2, sulphur trioxide, SO2, sulphur sesquioxide, S2O3, and persulphuric anhydride, S2O7. The dioxide has been known since the earliest times and is found as a naturally occurring product in the gaseous exhalations of volcanoes and in solution in some volcanic springs. It was first collected in the pure condition by J. Priestley in 1775 and its composition determined somewhat later by A. L. Lavoisier. It is formed when sulphur is burned in air or in oxygen, or when many metallic sulphides are roasted. It may also be obtained by heating carbon, sulphur and many metals with concentrated sulphuric acid: C + 2H2SO4 = 2SO2 + CO2 + 2H2O; S + 2H2SO4= 3SO2+2H2O; Cu + 2H2SO4 = SO2 + CuSO4 + 2H2O; and by decomposing a sulphite, a thiosulphate or a thionic acid with a dilute mineral acid. It is a colourless gas which possesses a characteristic suffocating odour. It does not burn, neither does it support com­bustion. It is readily soluble in alcohol and in water, the solution in water possessing a strongly acid reaction. It is easily liquefied, the liquid boiling at —8° C., and it becomes crystalline at —72∙7° C. (Walden, *Zeit, phys. Chem.,* 1902, 43, p. 432). Walden (ibid.) has shown that certain salts dissolve in liquid sulphur dioxide forming additive compounds, two of which have been prepared in the case of potassium iodide: a yellow crystalline solid of composition, KI∙14∙SO2, and a red solid of composition, KI∙4SO2. It is decom­posed by the influence of strong light or when strongly heated. It combines directly with chlorine to form sulphuryl chloride and also with many metallic peroxides, converting them into sulphates. In the presence of water it frequently acts as a bleaching agent, the bleaching process in this case being one of reduction. It is frequently used as an “ antichlor,” since in presence of water it has the power of converting chlorine into hydrochloric acid : SO2 + Cl2 + 2H2O = 2HCl + H2SO4. In many cases it acts as a reducing agent (when used in the presence of acids) ; thus, permanganates are reduced to manganous salts, iodates are reduced with liberation of iodine, &c., 2KMnO4 + 5SO2 + 2H2O=K2SO4 + 2MnSO4 + 2H3SO4; 2KlO2+ 5SO2 + 4H2O = I2 + 2KHSO4 + 3H2SO4.