On the Electron Drift Velocity in Solid Neon

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The electron drift velocity in solid neon is reported for the field strength range 1 to 50 kV cm^{-1}.

The electronic transport properties of solidified rare gases have received continuing interest since these materials represent the most simple solids. Detailed measurements of the electron drift velocity as a function of field strength were reported for sAr, sKr, and sXe by Miller, Howe, and Spear [1]. The low field mobilities were 1000, 3700, and 4500 cm^2 V^{-1} s^{-1}, respectively. In solid helium, on the other hand, Keshishev [2] reported mobilities of 10^{-5} cm^2 V^{-1} s^{-1} or lower for the negative charge carrier. Although some unpublished data on solid neon of Spear's group have appeared in a later review [3], no data on the field dependence of the electron drift velocity in sNe have been published so far. Recently, interest in the application of solid neon as detection medium in ionization chambers for high energy physics has developed [4]. During our investigation of the transport properties of excess lectrons in liquid neon we also measured the electron drift velocity in solid neon. These results are presented here.

The experimental set-up has been described in detail already [5]. Excess electrons were injected into the solid neon by illumination of a metal cathode of a diode cell with a strong light pulse from an excimer laser. The pulse duration, approximately 8 ns, was short compared to the drift time of the electrons.

An example of the photocurrent as a function of time is shown in Figure 1. The yield of injected electrons, as determined by integrating these curves, rose almost linearly to approximately 2% of the vacuum yield at 50 kV/cm.

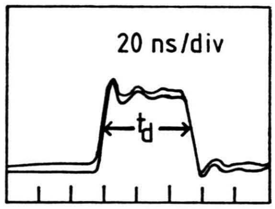

Fig. 1. Oscilloscopic trace of the photocurrent signal in solid neon at 8.75 kV/cm.

The electron drift velocity as a function of the applied electric field is given in Figure 2. Below 1 kV cm^{-1} no data could be obtained since the signal to noise ratio became too small. In the range of field strength from 1 kV cm^{-1} to 50 kV cm^{-1} a sublinear dependence of v_d on E is observed, which is indicative of hot electron effects. Above 30 kV cm^{-1} the drift velocity saturates and the value of $v_{ds} = 1.9 \times 10^6$ cm s^{-1} is in line with the values of sAr (1.07×10^6), sKr (0.76×10^6), and sXe (0.56×10^6). For values of the electric field strength smaller than 1 kV cm^{-1} the dependence was extrapolated according to the behavior of solid argon and taking into account a low field mobility value of $\mu_0 = 600$ cm^2 V^{-1} s^{-1} as quoted by Spear et al. [3].

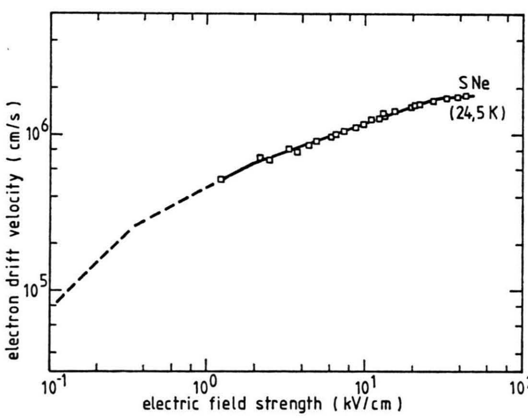

Fig. 2. The field dependence of the electron drift velocity in solid neon (24.5 K).

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[1] L. S. Miller, S. Howe, and W. E. Spear, Phys. Rev. **166**, 871 (1968).
[2] K. O. Keshishev, Sov. Phys. JETP 45(2), 273 (1977).
[3] W. E. Spear and P. G. LeComber, Chapter 18 in "Rare Gas Solids", M. L. Klein and J. A. Venables, eds., Vol. 2, Academic Press, New York 1977, pp. 1119.
[4] V. Brisson, Ch. Gregory, J. Morinand, and P. Petian, Phys. Scripta **23**, 688 (1981).
[5] Y. Sakai, H. Böttcher, and W. F. Schmidt, J. Electrostatics (1982), in press, and Proc. 7. ICDL, p. 46, Berlin, July 1981, IEEE Rep. No. 81CH1594-1.