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Appendix

A1. Formation of depletion layer (liquid junction)

It is considered that positive (*p*–) ions are injected into uniform electrolyte filled with negative (*n* –) ions. *p* - ions diffuse to *n* - side by the gradient of density. *n* – ions diffuse to *p* – side simultaneously. Coulomb's force appears between diffused *p*- and *n*-charges. When diffusion and Coulomb's forces are balanced, diffusion stops as shown in Fig. A-1(a).

Depending on the difference of potentials in *p*- and *n*-zones, a potential wall appears with space charges distributed at each side of space as shown in Fig. A-1(b). If any charges are in the space, they are driven out of the space. This is denoted a depletion layer.

The equational analysis is written in [3].

A glass electrode is inserted into the cytoplasm of a test cell. When the cytoplasm and solutions in the electrode are different, the potential difference appears between true and experimental observations. This effect is well known in solid (semiconductor) and liquid sciences.

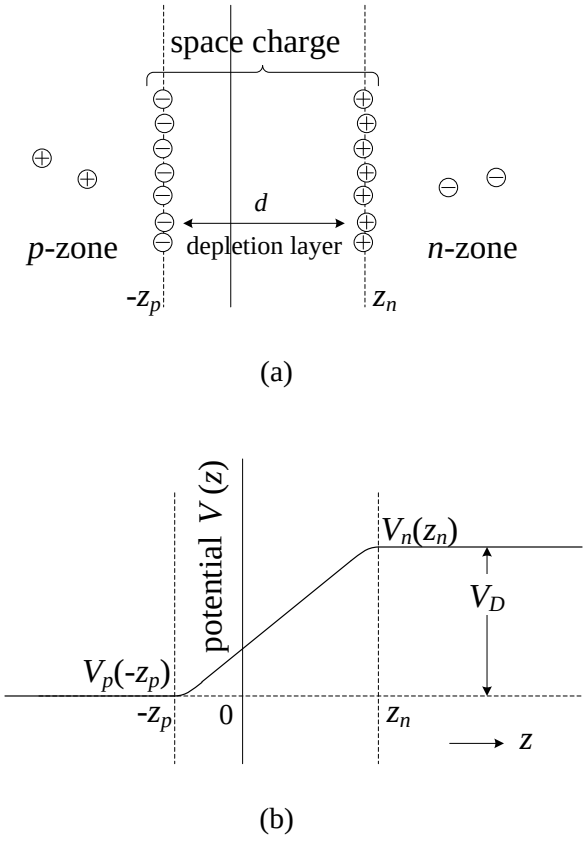

Fig. A-1 Depletion layer (liquid junction) composed of space charge and potential difference at a *p* – *n* boundary.
(a) Space charge distribution
(b) Potential difference