1. Introduction

In the following review we will deal with electron emission from solid surfaces resulting from impact of relatively slow particles (in the given context we denote by particle any neutral or charged atom, molecule or cluster, whereas electrons as projectiles remain definitely excluded unless explicitly stated). By slow we refer qualitatively to the impact energy range below one keV/amu (impact velocity below 0.2 amu ≈ 4 × 10^5 m/s). Phenomena related to particle-induced electron emission ("PIE" – the rather common use of "secondary electron emission" for such processes should be avoided) from solid surfaces can be roughly ascribed to two different mechanisms:

Kinetic Emission ("KE") is caused by transfer of kinetic projectile energy onto the electrons and atomic cores in the solid or in some adsorbates at the solid surface, which may result in a variety of physical processes eventually leading to the ejection of electrons from the solid surface. In KE processes the kinetic energy and mass of the projectile are of foremost importance, whereas a number of other projectile properties as its chemical configuration (atomic or molecular or clustered), charge state (neutral or positively singly or multiply charged or negatively charged) and electronic, vibrational or rotational state (in respective ground state or excited states) are usually not of concern. However, this assumption is only justified at relatively high impact velocity. In the context of the present review we will sometimes check the extent of its applicability. Since KE from its very principle should disappear toward low impact velocity, a corresponding threshold impact velocity should exist, but its precise location is generally not well defined.

The physical processes and experimental experiences related to KE are discussed at length in a review by Hasselkamp (1991) in this volume.

Potential Emission ("PE") is the principal mechanism for electron emission if the kinetic energy of the projectile remains of less influence than its "internal" properties which have just been mentioned. For slow projectiles the charge state plays a rather significant role on the electron emission, and the projectile species is also of concern because of the potential energy related to ion production from the corresponding neutral atomic or molecular ground state species. This potential energy is carried by the ion toward the solid surface.

*List of Abbreviations see end of this chapter.
and deposited during recombination of projectiles into their neutral ground state. Recombination involves various rapid electronic transitions which may lead to the electron emission.

It is important to note that the PE processes do not require any kinetic projectile energy and therefore no impact velocity threshold is given. However, toward higher impact velocity the PE processes will become superimposed by KE effects which then eventually may dominate (see above).

In the present review we are primarily interested in such low projectile velocities where the PE contributions remain dominant. We will be using the acronym "sPIE" for slow particle-induced electron emission as a qualitative distinction against KE-dominated processes, which are the subject of other contributions to the present volume.

For most practical applications of PIE the involved impact velocities are not sufficiently low to exclude KE influences completely or even approximately. Therefore it will be necessary to regard the influence of KE in all studies on PE where the projectile velocity reaches up to or surpasses the corresponding KE threshold region.

In the earlier literature on PIE, informations on potential emission are rather scarce and – almost as a rule – not very reliable. Only a few groups have produced still nowadays valid experimental data, mainly because of the very important influence of target surface conditions on the PE process and the comparably small PE contributions in the presence of usually more important KE-related background effects.

In first place we refer to the important studies of H.D. Hagstrum at Bell Laboratories/USA, which started in the early fifties and can be regarded as the foundation of modern PE work both from an experimental (Hagstrum 1953, 1954a, Hagstrum et al. 1965, Chaban et al. 1990) and theoretical (Hagstrum 1954b, 1977) point of view. Seminal contributions to the field of PE have also been provided by experimental work of U.A. Arifov and coworkers in Tashkent/USSR (Arifov et al. 1969, 1971) with the support of a strong theoretical group. Publications from both groups serve as valuable sources for earlier studies in the field. General reviews on both experimental and theoretical contributions from other groups active in the fifties and early sixties have been given by Kaminsky (1965) and Carter and Colligon (1968). Some informations on PE can also be found in treatises on gaseous electronics and related fields, cf. e.g. McDaniel (1964), but to our knowledge there exists no recent extensive survey dealing specifically with PE. However, the processes fundamental to potential emission are commonly included in the numerous surveys on PIE.

Investigations of potential emission have long been plagued by their extreme surface-sensitivity and the related experimental demands on ultrahigh vacuum conditions and target preparation. In fact, Hagstrum has utilized the very surface sensitivity of PE for a particular surface spectroscopy (so-called ion neutralisation spectroscopy – “INS”, Hagstrum 1956a, 1978), which