Excitonic Effects on Photoelectron Scattering in N_2 doped solid Kr

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In Rare Gas Solids the energy loss rate of photoelectrons with energies above the band gap energy is mainly determined by electron-electron scattering. The scattering of a hot photoelectron by a valence electron results in the formation of an additional electron-hole pair which can be bound or free. Such processes of multiplication of excitations with well-defined thresholds lead to prominent structures in the photoluminescence excitation spectra [1]. Solid krypton doped with N_2 was extensively used to investigate intra- and intermolecular energy relaxation into the impurity subsystem. Because of the fast electronic relaxation by the intersystem crossing to the lowest excited $A^3\Sigma_u^+$ state and the pronounced Vegard-Kaplan bands emission, N_2 can be used as a sensitive luminescent probe to detect electronic relaxation at an impurity. This paper reports the observation of exciton creation during inelastic photoelectron scattering and its effect on luminescence from N_2 doped solid Kr.

The photoluminescence experiments were carried out at the SUPERLUMI experimental station at HASYLAB, DESY, Hamburg. Solid krypton exhibits strong effects of neutral and charged defect formation induced by electronic transitions. Therefore all measurements were carried out after saturation of dose effects at steady concentration of point defects and ionic centers. Under selective excitation by synchrotron radiation the threshold energies for multiplication of electronic excitations were measured. The data obtained suggest that in N_2 doped solid Kr three types of photoelectron scattering exist: (i) photoelectrons with energies above $2E_g$ can create intrinsic ionic centers as a result of formation of secondary electron-hole pairs during scattering (ii) long-range photoelectrons are scattered inelastically by the impurity molecules, (iii) short-range photoelectrons with energies about $E_g + E_{exciton}$ generate excitons. The influence of mean free path of photoelectrons on scattering process is discussed.

[1] A.N. Ogurtsov, Advances In Spectroscopy of Subthreshold Inelastic Radiation-Induced Processes in Cryocrystals, in Spectroscopy of Emerging Materials, Kluwer, 45 (2004).