E-beam Tomography of Planar Semiconductor structures

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SEM based methods are very promising for the semiconductor structure characterization with a submicron resolution. For some structures the lateral resolution better than 0.1 mm can be achieved even in the EBIC mode in which electrical inhomogeneities can be revealed. But in many cases the spatial resolution of SEM methods are restricted by the large diffusion length and large enough dimensions of signal formation region and is much worse than the focused electron beam size. In some cases the resolution could be improved by the tomography methods but as a rule such approach needs the extremely high measurements precision. The quite different "apparatus" approach to the realization of SEM layer-by-layer tomography in which the reconstruction of internal structure and physical properties depth distribution is achieved by means of specially designed setup and applications of such SEM "apparatus" tomography methods for nondestructive characterization of multilayer planar semiconductor structures have been discussed. It has been shown that measurements of backscattering electron (BSE) coefficient dependence on the electron beam energy and an application of energy dispersive BSE mode allow to reconstruct the thickness and depth of layers in the structure under study with thickness as small as 10 nm. The possibilities of reconstruction of diffusion length and dopant concentration depth distribution by the electron beam induced current (EBIC) mode with a modulation of depletion region width have been discussed. It is shown that the depth resolution in this method depends mainly on the dopant concentration and measurement precision and can achieve a value about 10 nm. It is demonstrated that this technique allows also to measure the diffusion length in thin layers with the thickness much smaller than the diffusion length value. The possibilities of reconstruction of optical properties distribution with the improved spatial resolution by the cathodouminescence with a modultion of electron beam energy and intensity have been discussed.