Laser focusing system to produce high-brightness polarized electron beam for SPLEEM

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LEEM (Low Energy Electronic Microscope) is suitable apparatus for real-time-imaging of nano-size surface structure. In addition, SPLEEM (Spin Polarized LEEM) is quite useful to observe micro-structure of magnetic domain. However, the present SPLEEM apparatus can not take an image in real-time, due to a lack of beam-brightness of polarized electron source (PES).

In order to take the image of surface magnetic domain in special resolution of order of 10 nanometers in real-time, it is necessary to increase brightness of polarized electron beam in two order of magnitude compared the present source.

For this purpose, we proposed a new type PES with a transmission type photocathode, that is the laser photons injected from backside of photocathode excite valence electrons to conduction band and a part of those electrons are emitted forward into vacuum and accelerated.

This transmission photocathode enables the shorter distance between a focusing-lens of laser light and photocathode than reflection type photocathode, and makes it possible to have the smallest laser spot size on photocathode.

In our experiments, a high numerical aperture lens (NA=0.5) with a short focal length (f=4mm) is employed to decrease diffractive effect, and placed in distance of several mm from the photocathode crystal. As a result, a parallel laser beam with 3mm diameter is focused in the superlattice structure crystal into a spot with a diameter less than 10μm.

In this report, detail of this laser focusing system are described