function of the primary positron energy (black dots), as well as the elastic positron scattering as a function of primary positron energy (open red dots). One can see a clear diffraction pattern at about 16 eV. A low-energy maximum at about 10 eV is not identified and may be due to multiple positron scattering on the surface potential barrier. The intensity of the electron emission as a function of the positron primary energy is shown by red bold dots.

One can see a maximum on this curve at about 16 eV (or 13 V moderator potential), that coincides with the diffraction maximum of the positron scattering probability curve. This feature indicates that a substantial number of electrons are generated by the diffracted positrons and that these electrons are generated by positrons that underwent first diffraction on the W(001) crystal. Since the electron and positron curves do not look identical, some number of electrons is generated in alternative channels. For example, an incident positron first excites an electron (that can escape) and after that it either annihilates or scatters back into the vacuum.

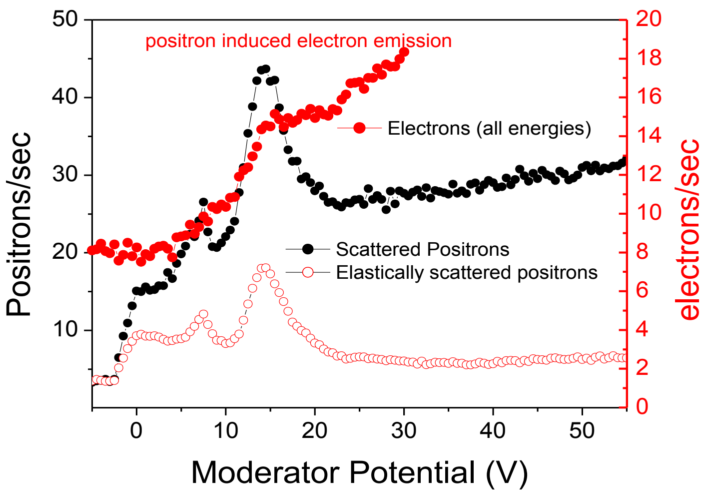


*Figure 49: Positron scattering probability as a function primary positron energy (black dots); Positron elastic scattering probability as a function primary positron energy (red open dots); electron emission intensity as a function of the primary positron energy (filled dots).*

**Interaction of spin-polarized electrons with surfaces**

We continued the study of thin ferromagnetic layers on a nonmagnetic substrate, using spin-polarized single- and two-electron spectroscopy. Spin-polarized electron energy loss spectroscopy (SPEELS) provides information on the magnetic state of the sample, in the form of the Stoner excitation asymmetry. It turns out that the magnitude and shape of the spin asymmetry from SPEELS, depends on the kinematics of scattering as well as on the magnetic state of the sample.

*Influence of kinematics on the Stoner excitation asymmetry*

We have measured the intensity asymmetry of SPEELS for a 5 ML Fe film on W(110), at the two different geometrical arrangements depicted in Figure 50: a) normal incidence and detection of electrons at 50˚ with respect to the sample normal; b) specular geometry with the angle of incidence at 25˚ and the detection angle at 25˚. The asymmetries of the energy loss spectra measured in the two different geometries are shown in Figure 50 (overleaf). The maximum absolute values of the Stoner excitation asymmetry at normal incidence and at the specular reflection at 25˚ are almost the same, but the shapes of the asymmetry spectra are different. At specular reflection the asymmetry changes sign at about 14 eV and there is a distinct kink at 5 eV energy loss. At the same time the asymmetry of the elastic maximum significantly

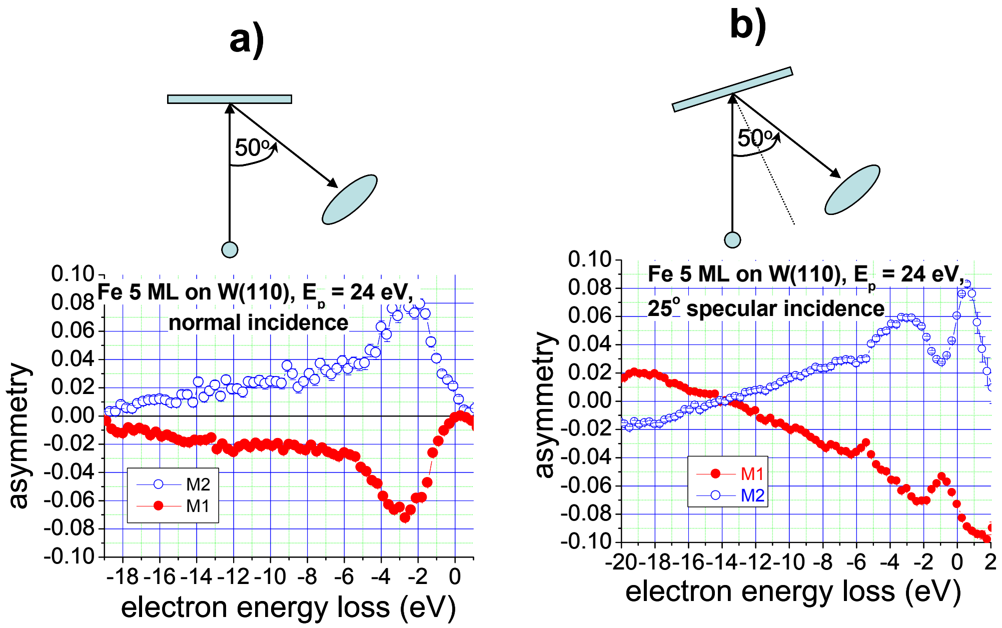


*Figure 50: Intensity asymmetry of SPEELS at different geometries of scattering.*

increases and exceeds the asymmetry of the Stoner excitation. Whereas for normal incidence the asymmetry does not change the sign in the whole energy range and the asymmetry of elastic scattering is zero. For both geometries the asymmetry almost ideally flips around the x-axis when the magnetization changes from M1 to M2 indicating a ferromagnetic (exchange) origin of the asymmetry. The shape of the Stoner excitations energy loss (and the asymmetry) depends to a large extent on the Stoner Density of States (DOS). The Stoner DOS is a joint density of states with the condition of a definite momentum transfer and with opposite spins of the electron and the hole. This means that this shape probably will depend on the momentum transfer which, in turn, depends on the kinematics of electron scattering. Also the energy- and momentum-transfer-dependent matrix element for the exchange process might be responsible for the change of the shape in the Stoner excitation asymmetry.

### *Film structure and the Stoner excitation asymmetry*

It is known [23] that the structure (morphology) of a ferromagnetic film influences it's magnetism, and this shows up in SPEELS. We studied a 5 ML Fe film on W(110) using SPEELS. A 5ML Fe film was deposited on a clean W(110) substrate. The LEED pattern taken just after deposition at 119 eV electron energy is shown in Figure 51a. The diffuse spots represent the mean position of the pattern of the Fe(110) structure. A very gentle annealing of the film (about 450 K) leads to the sharp pattern of multiplets arranged symmetrically around the reflections of the bulk Fe(110) surface (Figure 51b). Further annealing (up to 600K) results in the sharp LEED pattern corresponding to the superposition of the patterns of the W(110) and Fe(110) surfaces (Figure 51 c). The current and time indicated in the caption of Figure 51 show the current through the heating filament behind the sample and the time between "ON" and "OFF"

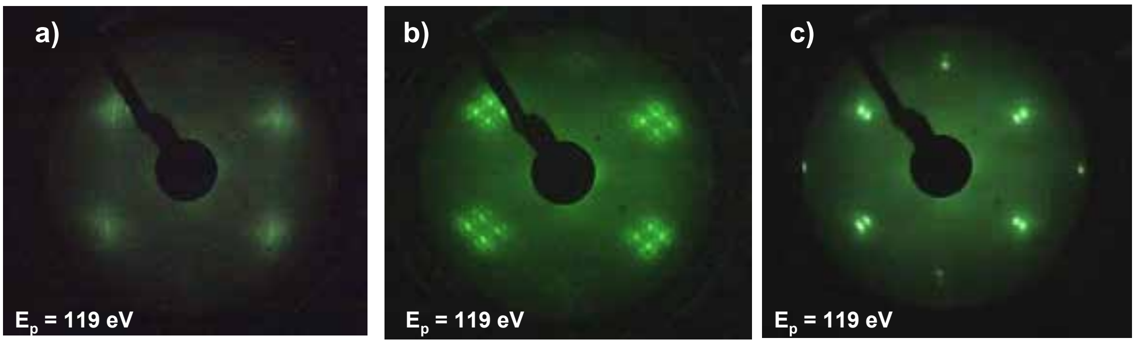


*Figure 51: LEED patterns for 5 ML Fe film: a) as deposited; b) annealed: 1.7 A x 2 min (about 450 K ); c) annealed: 1.7 A x 5 min (about 600 K).*

of that current. In the parentheses the estimated temperature reached at the end of the annealing is shown. The temperature was estimated using a thermocouple mounted behind the sample. It was close, but not connected, to the sample to allow azimuthal rotation of the sample and therefore the temperature measured was underestimated. For each of the three structures a), b) and c) of Figure 51 we measured SPEELS spectra, and the asymmetries of Stoner excitations for these spectra are shown in Figure 52.

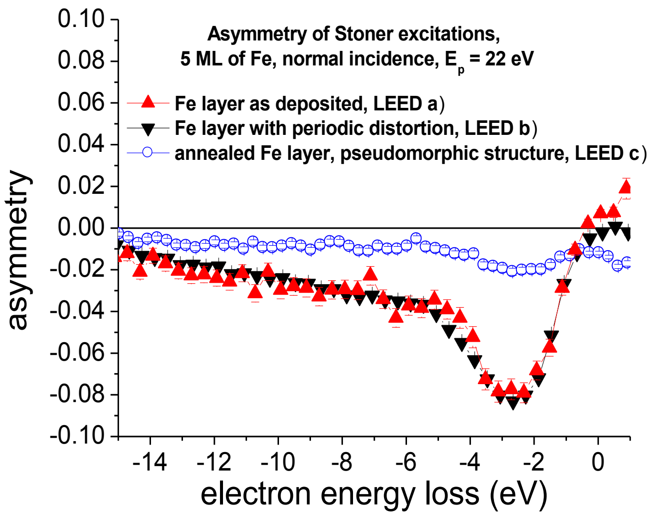


*Figure 52: Asymmetries of the Stoner excitations for 5 ML Fe films of various structures (see also the LEED patterns in Figure 51).*

One can see that the Stoner excitation asymmetries for the first two cases are the same: -8 %, with the position of the minimum at 2.5 eV energy loss. For the annealed film characterized by the LEED pattern c) of Figure 51, the absolute value of the Stoner excitation asymmetry reduces by a factor of 4 down to -2 % and the position of the minimum is shifted to about 2 eV energy loss. The reduced asymmetry indicates the reduction of the average magnetic moment of the film along the polarization vector of the incident electron beam. The reason for that, most likely, is that the film has lost its continuity during annealing, i.e. the film is broken into small islands. The average magnetic moment of the film along the Y direction then becomes very small. That might be due to: i) the paramagnetic state of the majority of these nano-size islands or ii) reorientation of the magnetic moments of the islands, i.e. individual magnetic moments of these islands are not pointing along the direction of the magnetic moment of the original (continuous) film. The suggestion about the disintegration of the film into islands is supported by measurements of Auger spectra for films b) and c).