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**Relativistic Electron Acceleration by Surface Plasma Waves in the High Intensity Regime** XIAOMING ZHU, MIRELA CERCHEZ, MARCO SWANTUSCH, BASTIAN AURAND, RAJENDRA PRASAD, ILPP, Heinrich Heine University Duesseldorf, D40225, Germany, ALEXANDER ANDREEV, Vavilov State Optical Institute, Sankt Petersburg, Russia, OSWALD WILLI, ILPP, Heinrich Heine University Duesseldorf, D40225, Germany — High field plasmonics is one of the new research fields which has synergetically benefited from the advances in laser technology. The availability of radiation fields of intensities exceeding $10^{18}\,\mathrm{W/cm^2}$ brought plasmonics into a new regime where relativistic and nonlinear effects start to dominate the dynamics of the surface plasma waves (SPWs). Moreover, surface plasma waves are a very efficient route to transfer the laser energy to the secondary sources including laser driven particle and radiation beams and to control and optimize the physical properties of these sources. We present here experimental evidence of a novel regime of the SPWs excitation by ultra-high intensity laser field ($\mathrm{I}>10^{20}\,\mathrm{W/cm^2}$) on grating targets and its effect on high energy surface electron acceleration. The peak of the electron emission was detected at a laser incidence angle of 45. The results indicate new conditions for resonant excitation of SPWs since in the limit of the linear regime (moderate intensities of ˜$10^{19}\,\mathrm{W/cm^2}$ and step preplasma profile), the resonance angle is predicted at 30. 2D PIC simulations and a novel analytical model confirm the experimental data and reveal that, at laser intensities above $10^{20}\,\mathrm{W/cm^2}$, nonlinearities induced by the preplasma condition and relativistic effects change the SPWs resonance.

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