Solar Cell Processing by Nanosecond Pulsed Fiber Laser Amplifier

Yigit Ozan Aydin[1,2,3], Firat Es[2,3], Mona Zolfaghari[2,3], Alpan Bek[2,3,4]

1. *FiberLAST Inc, ODTU Teknokent Galyum Z3, 06800, Ankara Turkey*
2. *Middle East Technical University, Micro and Nanotechnology Program, 06800, Ankara, Turkey*
3. *Middle East Technical Univeristy, GUNAM – The Center for Solar Energy Research and Applications, 06800, Ankara, Turkey*
4. *Middle East Technical University, Department of Physics, 06800, Ankara, Turkey*

The laser material interaction is one of the ever-growing fields of science for years and progresses parallel to designing new laser systems. Material processing with lasers has several advantages compared with traditional methods. One of the main advantages is the ability to control laser beam and its energy exposed on the material with high precision. The second main advantage is that the processing techniques with laser are very cost effective since laser processing is non-contact and eliminates tool wearing. Third, it is a chemical free application, thus can be considered a clean technique for processing materials. Fourth, it is possible to remove parts of the processed material by adjusting the wavelength or intensity; selective material removal is possible without damaging the under layer.

In this work, modification of several types of materials are studied by a 60 W nanosecond pulsed fiber laser amplifier which has recently been developed by our group [1]. By taking advantage of independently adjustable repetition rate and pulse duration of laser beam, we aimed to show the effects of laser pulses on precise material processing applications, especially in solar cell technology. The impact of the laser parameters on bulk and thin film processing were investigated in various applications. Firstly, solar cell edge isolation process with fast processing speed was performed to achieve high quality isolated zones and the effects of the laser beam with variable parameters on Si based cells have been determined. After pulsed laser isolation process, we achieved an extra ~2% efficiency on a full scale wafer while processing the wafer with 2000 mm/s scanning speed. Secondly, a scribing application on thin film was demonstrated. For this purpose, laser beam removal of molybdenum and indium tin oxide thin film layers from substrates has been characterized. The laser amplifier is capable of ablating the materials from the surfaces of the substrates by using a high intensity laser beam to vaporize the material from surface. In the first application, we have taken advantage of the laser's high average power and energy to achieve an increased scan speed compared with commercially available industrial lasers. In the second application, we have taken advantage of the independently adjustable pulse duration and repetition rate to achieve a high quality thin film removal.

[1] Y.O.Aydin, "Development of a 60 W Pulsed Fiber Laser Amplifier for Materials Processing" Middle East Technical University (2014).