ROUGH CIGS SURFACE ANALYZED WITH RAYLEIGH-RICE THEORY

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We employ Müller matrix ellipsometry to study the high efficiency thin film photovoltaic material copper indium gallium selenide $Cu(In,Ga)Se_2$ (CIGS) [1]. The analysis is complicated by a surface roughness with an rms value of 68 nm, measured with confocal microscopy. We use Rayleigh-Rice (RR) theory [2] to take the optical effect of this surface roughness into account. The roughness parameters σ (rms height of roughness) and ξ (roughness correlation length) are found from the Müller parameters by comparing them to calculations based on RR theory for a library of structures. Figure 1 shows the measured data and the optimal calculated solution.

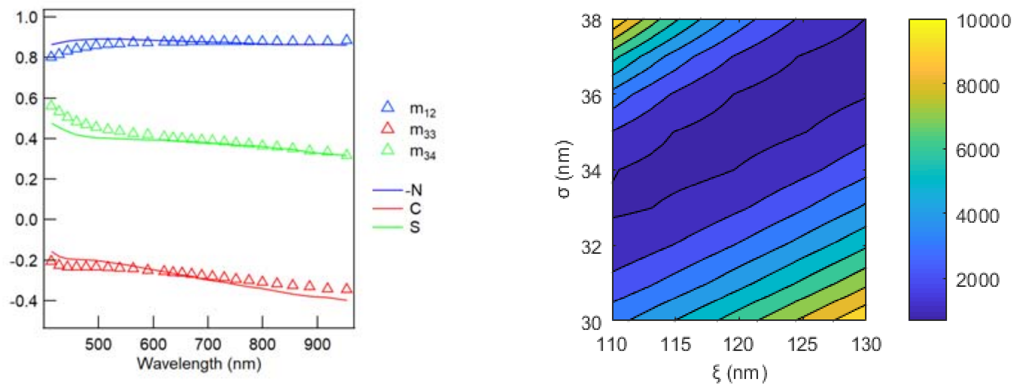

Figure 1. Left: Experimental Müller matrix elements (m_{12}, m_{33}, and m_{34}) and best calculated solution (N, C, and S) corresponding to σ = 36 nm and ξ = 125 nm. Right: Error χ^2 of comparison between experimental data and model as function of the roughness parameters σ and ξ.

The roughness parameters extracted from the analysis are comparable to values found using confocal microscopy and AFM, showing that the Rayleigh-Rice model can be employed to account for roughness effects in ellipsometric measurements. We investigate if the difference between the methods could be due to the fact that ellipsometry is more sensitive to high spatial frequency roughness than low frequency components. We find that the observed ellipsometry sensitivity is almost independently of the spatial frequencies of the roughness.

Keywords: Müller matrix ellipsometry, Copper Indium Gallium Selenide, Rayleigh-Rice theory

References

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