Electrical property mapping of ZnO:Al films with micro four-point-probe technique

Crovetto, Andrea; Kjær, Daniel; Petersen, Dirch Hjorth; Schou, Jørgen; Hansen, Ole

Publication date: 2014

Document Version
Publisher's PDF, also known as Version of record

Link back to DTU Orbit

Citation (APA):

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain.
- You may freely distribute the URL identifying the publication in the public portal.

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.
**Motivation**

 Demonstrating the advantages of a micro-four-point probe setup for mapping electrical properties of transparent conductive films:

1. High spatial resolution
2. Non-destructive
3. Compatible with in-line processes
4. No sample preparation for Hall measurement
5. Error suppression by combining measurements from 7 probes

**Sheet resistance measurement**

![Sheet resistance measurement graph]

- Probe with smaller pitch is more sensitive to local variations and reduces correlation effects
- On a ~1 cm scale: Resistivity decreases due to increase in both carrier density and mobility
- On a ~100 µm scale: Carrier density and mobility vary in antiphase (measurement noise)

**Hall measurement**

- Measure $V_B$ and $V'_B$ close to an insulating boundary
- Determine Hall mobility and carrier density

**Burstein-Moss effect mapping:**

$$\Delta E_g = \text{const} \left( \frac{1}{m_e} + \frac{1}{m_h} \right)^{2/3}$$

$$\Delta E'_g: \text{optical band gap of ZnO:Al} - \text{(band gap of undoped ZnO)}$$

$n$: carrier density