Technische Universität Chemnitz
Professur für Mess- und Sensortechnik
Prof. Dr.-Ing. O. Kanoun

Master Thesis/Research Project

Optimizing the Sensitivity of Epoxy-Based Strain Sensors through Systematic Adjustment of Hardener and Flexibilizer Ratios and Curing Temperature

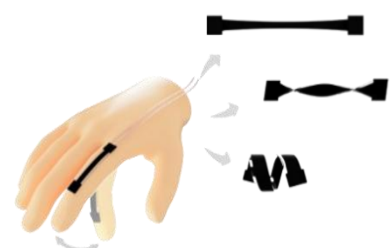
Project Description:

This research project aims to enhance the sensitivity and durability of epoxy-based strain sensors by systematically exploring and optimizing the ratios of hardener and flexibilizer in the epoxy resin, alongside variations in curing temperature. The sensitivity of strain sensors, reflected through their gauge factor, heavily depends on the mechanical characteristics of the polymer matrix, including elasticity, stiffness, and crosslink density. An appropriate balance between the hardener and flexibilizer significantly influences the polymer's mechanical and electrical response under strain. Higher hardener ratios typically improve stiffness and mechanical stability but may reduce flexibility and sensitivity. Conversely, higher flexibilizer content enhances sensor responsiveness but can potentially compromise mechanical integrity over prolonged use. Additionally, curing temperature profoundly affects the polymer's crosslinking behavior, directly influencing sensor performance and long-term stability.

The core objective is to methodically identify and optimize the interplay between these parameters to produce strain sensors with both superior sensitivity and mechanical robustness.

Key objectives include:

- Systematically vary and evaluate the impact of hardener-to-flexibilizer ratios in epoxy-based nanocomposites.
- Investigate the influence of curing temperature on the mechanical properties and sensor sensitivity.
- Correlate mechanical properties such as elasticity, stiffness, and elongation to electrical performance indicators, particularly gauge factor.
- Identify and validate the optimal epoxy formulation that provides high sensitivity without compromising durability and repeatability.



Tasks:

- Perform an extensive literature review on epoxy matrix modification strategies for strain sensor enhancement.
- Select suitable epoxy resin, hardener, flexibilizer, and nanofiller systems, ensuring compatibility, stable dispersion, and reproducibility.
- Fabricate epoxy-based nanocomposite films with systematic variations in flexibilizer and hardener ratios and curing temperatures.

- Characterize the sensors using comprehensive mechanical tests (tensile strength, elongation at break, modulus) and electrical measurements (resistance change, gauge factor under controlled strain conditions).
- Analyze structural properties via microscopy or spectroscopy techniques to understand polymer-filler interactions and matrix morphology.
- Optimize electrode integration and sensor fabrication processes based on iterative testing and performance evaluation under realistic conditions.
- Document and analyze experimental results thoroughly, leading to definitive conclusions on optimal formulations and curing conditions.
- Prepare detailed documentation, thesis writing, and presentation of findings.

Requirements:

- Background in materials science, engineering, or related fields.
- Proficiency in research methodologies and laboratory experimentation.
- Familiarity with polymer nanocomposites and characterization techniques.
- Strong analytical and problem-solving skills and self-driven research capability.
- Adaptability, motivation, and ability to work independently.

Supervisor:

Amoog Lakshmanan Chair of Measurements and Sensors Technology Reichenhainer Straße 70, Weinhold-Bau, C25.218 (alt: 2/W218) amoog.lakshmanan@etit.tu-chemnitz.de	Ahmed Attaoui Chair of Measurements and Sensors Technology Reichenhainersstr. 70, Weinholdbau, C25.283 (alt: 2/W283) Email: ahmed.attaoui@etit.tu-chemnitz.de