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Few-Shot Anomaly Classification in Semiconductor Process Control using Generative AI and Domain Adaptation

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Automatic anomaly classification in semiconductor manufacturing is often constrained by the limited availability of labeled data, particularly for rare anomaly types and early process ramp-up conditions. Anomaly simulation enables generation of labeled data at scale, however supervised classifiers trained on synthetic data frequently underperform on real production data due to synthetic-to-real domain shift. We present a unified framework that combines a few-shot synthetic anomaly generation (AnomalySim) followed by supervised domain adaptation (Domain Adaptor) to address both data scarcity and domain mismatch in a single, coherent training flow. AnomalySim leverages a small set of annotated real anomalies to generate diverse, class-consistent synthetic anomalies, increasing the effective size of the training dataset in low-label regimes. These synthetic anomalies are then used together with real samples to train a supervised classifier, while domain adaptation bridges the appearance differences between synthetic and real datasets. In our internal evaluations, this unified approach significantly outperforms the training with real data alone or the naïve mixing of real and synthetic data.