

# **Resonator-based microwave metamaterial sensors for instrumentation: survey, classification and performance comparison**

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## **Abstract-**

**Metamaterials are widely used as sensors in a large range of applications due to their unusual properties not found in nature. This review's purpose is to focus on recent metamaterial-based electromagnetic sensors, particularly on the structures that integrate the metamaterials in antenna or transmission lines for their further integration in measurement instruments. The approach followed in the review is to highlight sensitivity and quality factor (Q-factor) as they are crucial parameters in any sensor; the corpus of literature analyzed lead to the finding that the adoption of metamaterials are a key factor in successfully decreasing the size of the structures while maintaining a high Q-factor value and reducing losses. Additionally, a new metamaterial-based sensors' taxonomy is proposed to classify them into three main categories: frequency-variation sensors, coupling-based sensors and differential sensors. A tabular comparison of the specifications of different sensors provides further insights into their different capabilities and will allow future researchers to efficiently find and compare their prototypes with state-of-the-art devices.**

**Index Terms-** Metamaterial, sensors, bulk material detection, coupling-based sensors, differential sensors

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