New calculation method for simplified and automated determination of the properties of one or two porous etched silicon layers positioned on top of each other (e.g. for the production of silicon wafers by epitaxy)

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The innovative method simplifies and automates the determination of porosity, roughness and thickness of porous silicon films with single or double layers by using measured reflectance spectra in the visible spectral range.

- Faster and more accurate calculation of the parameters of porous silicon layer stacks
- In situ monitoring of the manufacturing process
- A spatial resolution of the data is possible
- The method has been optimized so that it can also be used by non-experienced users.

Fields of Application

The method can be used wherever it is required to calculate the parameters of porous silicon layer stacks by reflectance measurements in a faster and more accurate way.

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Service
Technologie-Lizenz-Büro GmbH has been entrusted with the exploitation of this technology and assists companies in obtaining licenses.

Background

The so-called transfer process allows silicon wafers to be produced at low cost by etching a porous layer stack on a silicon substrate wafer. In the next step, this stack is formed at high temperatures in a hydrogen atmosphere. A wafer is then epitaxially grown on top. The quality of the epitaxially grown wafer and the easiness of detaching it from the substrate wafer strongly depend on the properties of the porous layer stack.

A gravimetric method is usually used to determine both the thickness and porosity of individual porous layers. However, this is a destructive technique which only provides average values over a wide range.

In contrast, a spatially resolved reflectance measurement allows porous silicon films with single and double layers to be measured in the visible spectral range in a non-destructive fashion. A wide range of porosity (from 0 to over 90%) and film thickness (from about 10 nm to 10 µm), as well as the roughness of single and double porous silicon layers can be determined on the basis of the fit of these reflectance spectra.

This is where the novel process comes in - it simplifies this fit and makes it more robust.

Problem

In order to fit reflectance spectra, the commonly used Levenberg-Marquardt algorithm requires the start parameters to be very close to the expected values. Consequently, several attempts with different initial parameters are required to finally get a satisfactory and correct result. Therefore, a method was searched for that allows start parameters to be selected that are less close to the expected values. The result: a simpler and more robust process that is adaptable to different layer properties.

Solution

The novel method has already been implemented in software. Based on rough initial values, the software first determines initial values that are much closer to the expected values, which is essential for a successful fit.

Therefore, the process is based on the following simplifications:

- The values of some parameters are determined independently of the fit procedure.
- Selected parameters are fitted in a specific spectral range. This procedure makes sense, because each parameter has a certain influence on the spectrum (global reflection amplitude, local vibration amplitude, frequency, phases, etc.)
- Automatically selected initial values for the most sensitive parameters.