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Damping measurement via Impulse Excitation Technique at High Temperature

Introduction

Damping represents dissipation or absorption of vibrational energy by microstructural features in the material. Damping behavior may originate from multiple microstructural phenomena like grain boundary sliding, liquid phase formation, phase transition, diffusion, precipitation, crack propagation [1] and frictional processes at crack interfaces. Due to high sensitivity to the grain boundary characteristic, damping measurements can yield additional information about temperature-induced microstructural rearrangements, which is not easily detectable by other measurement techniques.

Principle and Test Procedure

In the impulse excitation technique, the sample's vibration is induced by a slight mechanical impulse. The transient vibration in the resonant mode is then detected by a non-contact transducer / microphone and the signal is further processed to extract a set of resonant frequencies. Specimen support, impulse location and signal detection are selected in order to induce the desired vibration mode.

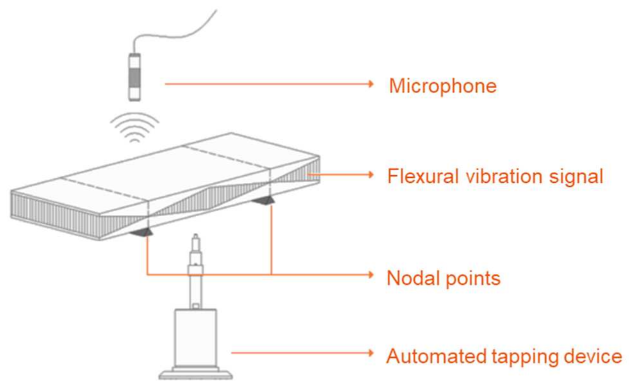

Figure 1 – Experimental setup (adapted from [2]).

The damping value for each frequency is calculated from the amplitude decay of a free vibration.
The Measurement setup is adjusted to high-temperature applications, in order to determine the temperature-dependent damping spectrum.

Expected Result

The Figure 2a shows typical temperature-induced damping characteristic of thermodynamically stable ceramic material with exponential increase at high temperatures. This behaviour is mainly attributed to the weakening and sliding of grain boundaries at high temperatures. Figure 2b presents damping spectrum with characteristic peaks superimposed on a wide exponential damping background. The presence of damping peaks is typical for materials undergoing thermally-activated rearrangement processes.

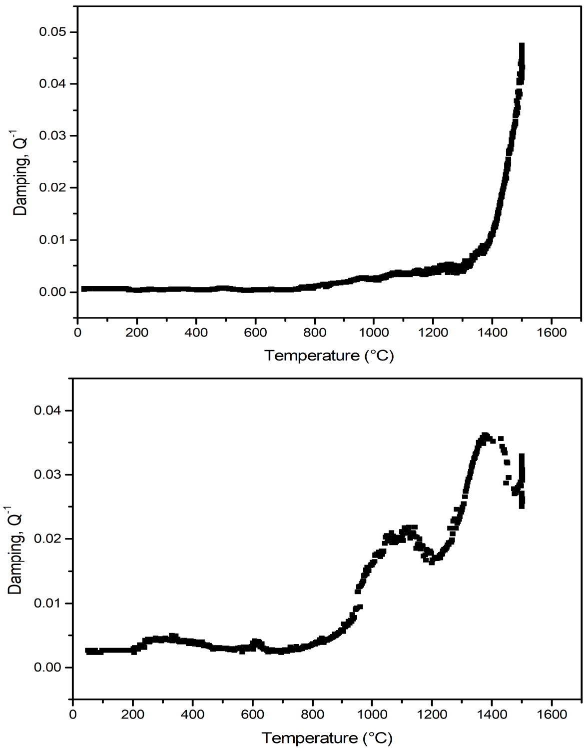

Figure 2 – Exemplary results for a) stable material with damping effect at high temperature and b) material with thermally-activated microstructural rearrangement

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References

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[2] https://www.imce.eu/

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