CIRMMT Residency Summary Report

Micro Computed Tomography of Reed Cane (Arundo Donax)

Student: Connor Kemp

CIRMMT Supervisor: Gary Scavone

Exchange Supervisor: Dominique Derome

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Beginning in September 2017, I spent one month at Empa in Zurich working with Dominique Derome and researchers in the Centre for X-ray Analytics on woodwind reed cane (Arundo Donax). This project is a collaboration between several faculties at McGill and Dr. Derome's lab at Empa. Dominique is considered an expert in characterization of wood under changing moisture conditions and the opportunity to work with her on this project is a great privilege. The purpose of this research was to develop a microstructural and anatomical understanding of reed cane under different conditions designed to emulate the conditions of reeds during normal playing. This work is important as conventional static measurements of reeds during manufacturing are inadequate for explaining the variability in mechanical stiffness and long-term degradation between reeds within a single box.

Experimental conditions included dry, 50% RH, 80% RH, 90% RH and fully saturated moisture states. These conditions were informed from data obtained from a player study conducted at McGill with Remi Bolduc. Reeds are also known to change significantly with time, and thus it was desirable to attempt to quantify the origins of these changes by artificially aging reed cane using deionized water and obtaining x-ray tomograms of sample volumes. Experiments performed included micro tomography of reed cane under different moisture conditions in order to observe the swelling behaviour of the microstructure and to quantify damage induced from exposure to prior saturation cycles. The facilities at Empa are capable of producing tomograms with sub-micron spatial resolution, with sample volumes of 1 to 1.5 mm^3. X-ray tomography is an ideal choice for experiments of this nature as it is non-destructive and does not require sample preparation that could alter/induce damage in the microstructure. It also permits full 3D analysis, which is not possible with several other characterization techniques (i.e., optical microscopy, electron microscopy, etc.).

The results of this study will help to inform reed manufacturers as to the primary causes of damage in reeds during their lifespan, and indicate anatomical identification methods for selecting reeds that will undergo more homogeneous swelling. In general, analysis of sub-volumes showed that reeds only swell significantly along their length, and suggests that warping due to repeated wetting and drying may be exacerbated by reeds with less microstructure symmetry along this direction. These results are also the primary microstructural characterization of reed material for comparison with nano-mechanical testing being performed at McGill. It was necessary to obtain these microstructural tomograms to aid in explaining the changes in mechanical properties that are observed for reeds during playing by musicians. Future and ongoing work will involve more rigorous anatomical characterization of the reed samples studied through full 3D reconstructions of the CT tomograms. This data can then be used to inform the development of models that better predict the vibrational behaviour of reeds. Comparisons will also be made with nano-mechanical results of the behaviour of individual microstructural constituents in order to explain differences observed between samples of different age (fatigue life).

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