

ALEXANDER MORIN: On the mechanics of regummed Bombyx mori silk composites

The present work concerns the production of environmentally valuable composite materials from degummed and then regummed Bombyx mori silk. Silk consists of two polymers, fibroin and sericin, the latter is usually removed during silk manufacturing processes. The re-application of sericin, which is typically deemed waste material, is of high importance to green technology. In this, both fibroin and sericin polymers were manufactured to develop novel green composite materials with a focus on their mechanical properties. Fibroin was degummed of its sericin from natural cocoons and then regummed into thin sheets using the separated sericin to adhere fibroin fibres back together. Molecular modelling revealed that a moisture rich environment during fabrication leads to superior intermolecular attachment of sericin to the fibroin. In addition, SEM revealed that fibres can bear more load if they oriented in one direction. Therefore, both principles were used to design the materials in view of their mechanical performance. Mechanical tests showed the tensile strength and stiffness properties of regummed silk biocomposites were far lower than for native silk cocoons. However, the elongation and toughness properties of regummed silk biocomposites were considerably higher than in native silk cocoons. Since quantitatively, the ratio of sericin to fibroin in the biocomposites were the same as in raw silk, alterations to the silk structure during processing are deduced to be the main reason for the significant differences observed in mechanical performance between the two. Detailed analysis of intermolecular interactions and changes in secondary structures using FTIR are described in the paper thus shedding light on native and regummed silk biocomposite properties and the potential for using regummed silk in material science.

KEYWORDS: silk, Bombyx mori, biocomposite materials