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Acrylic Bone Cement Reinforced with Halloysite Clay Nanotubes

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INTRODUCTION & AIM

Background: In the disciplines of orthopedics and dentistry, acrylic bone cement is frequently utilized for treating bone defects, securing prosthetic implants, remodeling osteoporotic deformities, and repairing fractures. Traditional acrylic bone cement has been found to have several disadvantages, such as prosthesis loosening, heat generation, inferior mechanical characteristics, and weak interface integrity. There was a strong need to improve its qualities; as such, recent research has shown that adding halloysite clay nanotubes (HNTs) to materials based on polymers can enhance their mechanical & thermal qualities. **Objectives:** We sought to assess the impact of adding 10 wt.% of HNT fillers to traditional acrylic bone cements to modify their compressive strength, flexural strength, and exothermic heat generation (maximum temperature).

METHOD

PMMA powder and monomer liquid were combined to create the control group, the reinforced group was made by mixing the PMMA powder with 10 wt.% HNT fillers before liquid mixing. Chemical characterization of the HNT fillers was employed by X-ray fluorescence (XRF). The morphological examination was done using a scanning electron microscope (SEM).

RESULTS & DISCUSSION

Table 1: Mean compressive strength, microhardness, solubility values between the two groups

	PMMA Bone Cement (control)	PMMA bone cement + 10 wt.% HNTs	P value
Compressive strength (MPa)	$76^{a}\pm1.9$	$93^{b}\pm1.2$	P=0.0001*
Flexural strength (MPa)	$51^{a}\pm1.2$	$72^{b}\pm1$	P=0.0001*
Maximum temperature (T max) (°C)	$40^{b}\pm0.7$	$34.8^{a}\pm0.1$	P=0.0001*

* indicates a significant difference as $P < 0.05$ for different small letters in the same row.

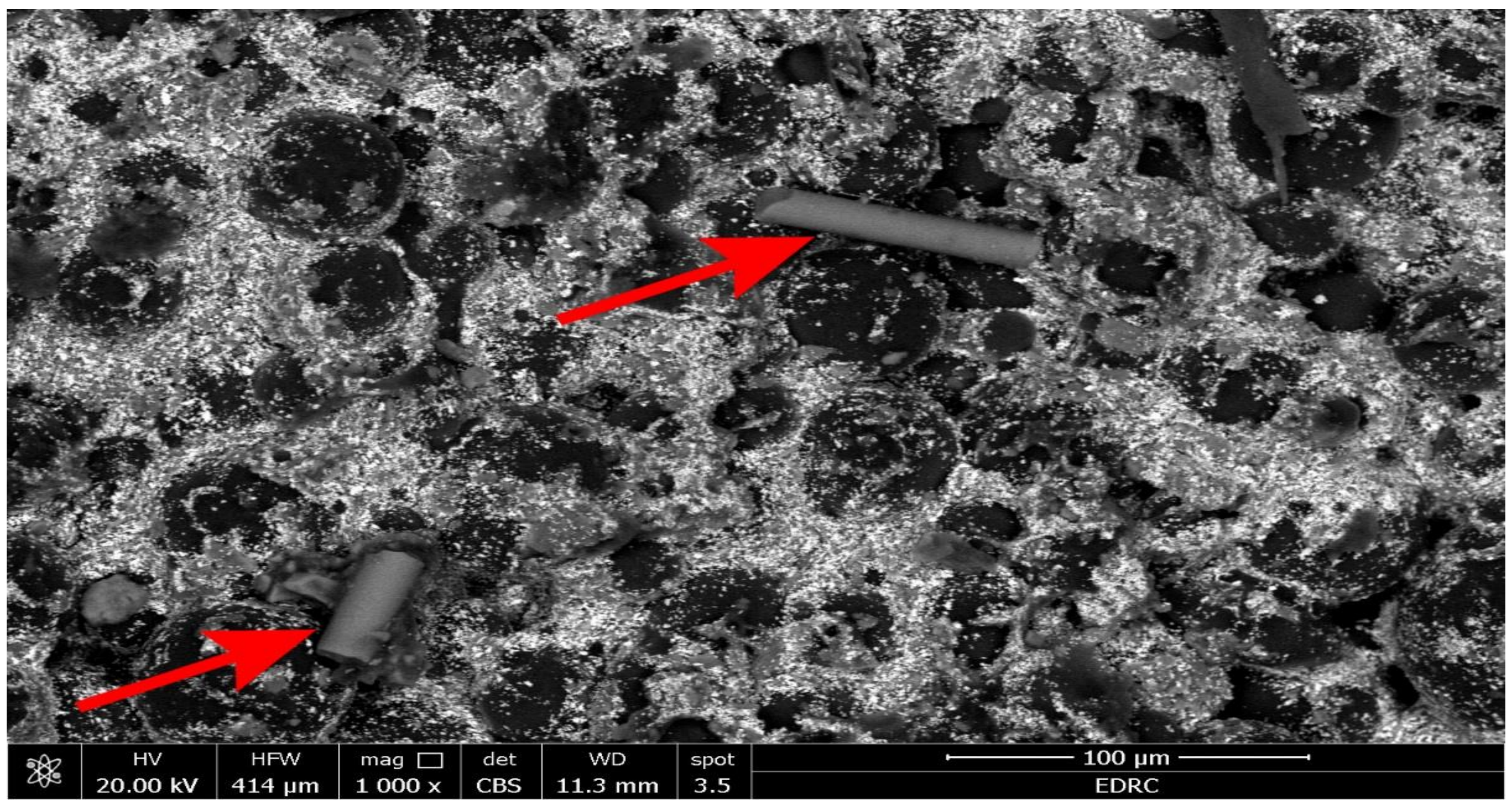

Figure 1: A representative SEM image of the modified group, the arrow refers to the HNT filler.

There was no significant difference in the setting time between the control and the modified groups. The enhancement in the mechanical properties may be attributed to the reinforcing action of HNT due to their high stiffness and high sensitivity to dispersion in the polymer matrix. The reduced maximum temperature may be explained by the insulated ceramic features of the incorporated HNT.

CONCLUSION

The novel PMMA-based bone cement with the addition of 10 wt.% HNTs can effectively be used in orthopedic and dental applications, as they have the potential to enhance the compressive and flexural strength and reduce the maximum temperatures.

FUTURE WORK / REFERENCES

It is recommended to investigate the effects of including HNT at higher concentrations

- *Ruiz Rojas LM, Valencia Zapata ME, Gordillo Suarez M, Advincula R, Grande-Tovar CD, Mina Hernández JH. Optimization of Mechanical and Setting Properties in Acrylic Bone Cements Added with Graphene Oxide. Appl Sci. 2021;11:5185.*
- *Fahimizadeh M, Wong LW, Baifa Z, Sadjadi S, Auckloo SAB, Palaniandy K, et al. Halloysite clay nanotubes: Innovative applications by smart systems. Applied Clay Science. 2024;251.*