Proc. of the 9th Intl. Conf. of Asian Society for Precision Engg. and Nanotechnology (ASPEN 2022)
15–18 November 2022, Singapore. Edited by Nai Mui Ling Sharon and A. Senthil Kumar
doi://10.3850/978-981-18-6021-8_OR-12-0318

Application of ultrasonic nanocrystal surface modification to improve cavitation corrosion resistance of nickel-aluminum bronze

Changliang Yao[1,2], Dosik Shim[1,2,#] and Sanghu Park[3]

1 Department of Ocean Advanced Materials Convergence Engineering, Korea Maritime and Ocean University, Busan 49112, Republic of Korea
2 Interdisciplinary Major of Ocean Renewable Energy Engineering, Korea Maritime and Ocean University, Busan 49112, Republic of Korea
3 School of Mechanical Engineering, Pusan National University, Busan 46241, Republic of Korea
Corresponding Author / Email: think@kmou.ac.kr, TEL: +82-51-410-4354, FAX: +82-51-410-4350

KEYWORDS: Nickel-aluminum bronze, Ultrasonic nanocrystal surface modification, Microstructure, Cavitation erosion

Nickel-aluminum bronze (NAB) is widely used to fabricate marine propellers owing to its excellent corrosion resistance and mechanical properties. During the service process of a propeller, it suffers from various types of damage and corrosion erosion. In addition to static corrosion, propellers suffer from cavitation corrosion when rotating at a high speed in seawater. Cavitation is defined as the damage of the shock wave impact on the components that is caused by the bubbles formed and collapsed in the liquid owing to local pressure fluctuations. Therefore, in this study, ultrasonic nanocrystal surface modification (UNSM) was applied to enhance the cavitation resistance of NAB. UNSM technology uses ultrasonic vibration energy to strike a certain area of the material to be processed tens of thousands of times per second with an amplitude of several micrometers (μm), thereby inducing severe plastic deformation on the surface. This could make the surface texture fine and improve the wear resistance and surface roughness of the product. After UNSM treatment, good surface roughness was obtained, and the hardness of the treated area significantly improved from 210 Hv to 360 Hv. The microstructure exhibited severe plastic deformation on the NAB surface after UNSM, and refined grains were observed. This was because as the material plastically deformed, the density of internal dislocations increased, and the material underwent strain hardening. Strain hardening increased with plastic deformation, resulting in greater hardness. In addition, cavitation resistance improved after UNSM treatment. Because cavitation is an erosion behavior dominated by mechanical impact, the cavitation resistance of a material is closely related to its hardness. This study shows that UNSM technology can effectively improve the cavitation resistance of the NAB surface and increase its service life.